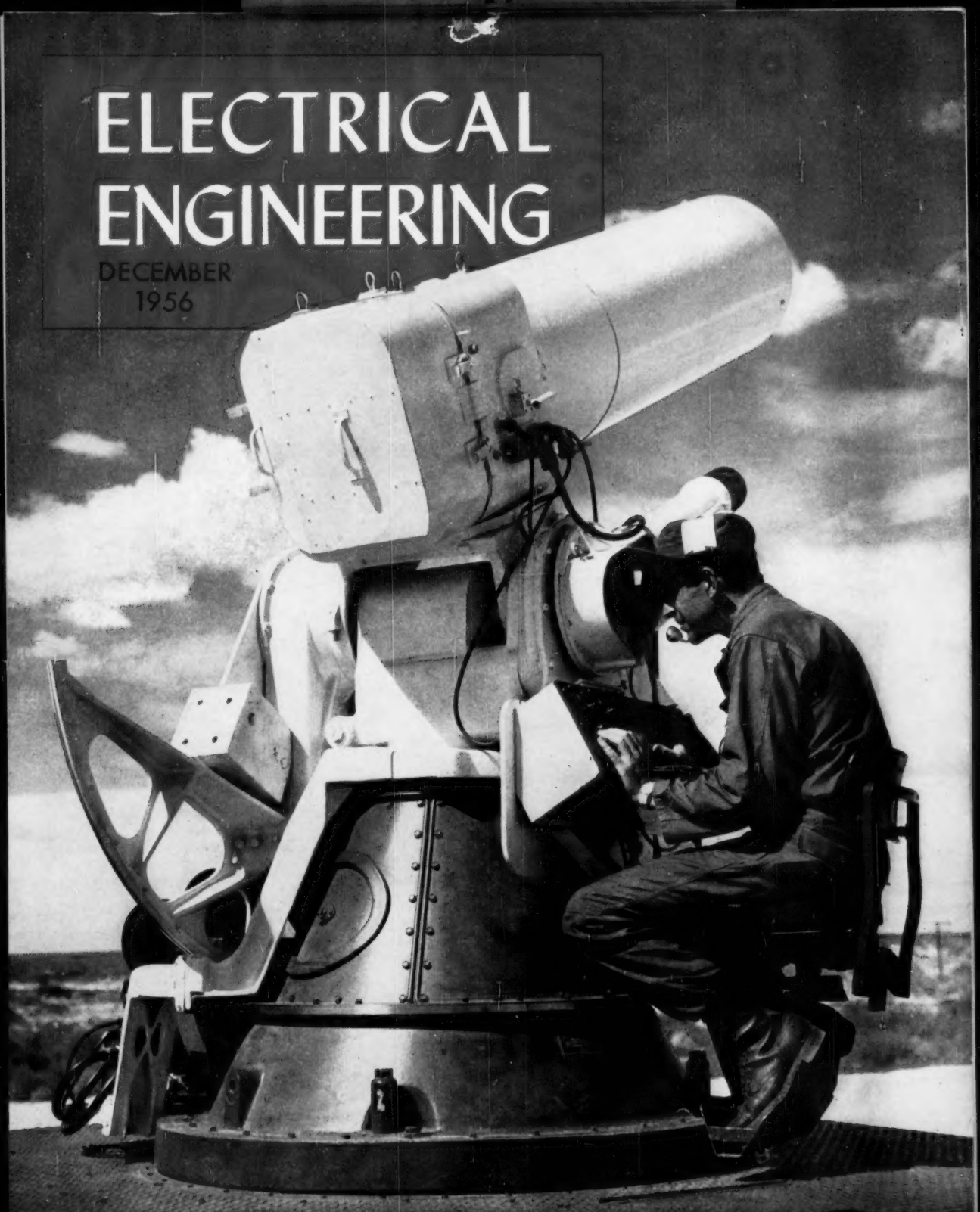
ELECTRICAL ENGINEERING

DECEMBER
1956



PRINCIPLES OF COMPUTER PROGRAMMING

EDUCATION AND THE ADVANCING TECHNOLOGY

CONTROL FOR RESEARCH NUCLEAR REACTORS

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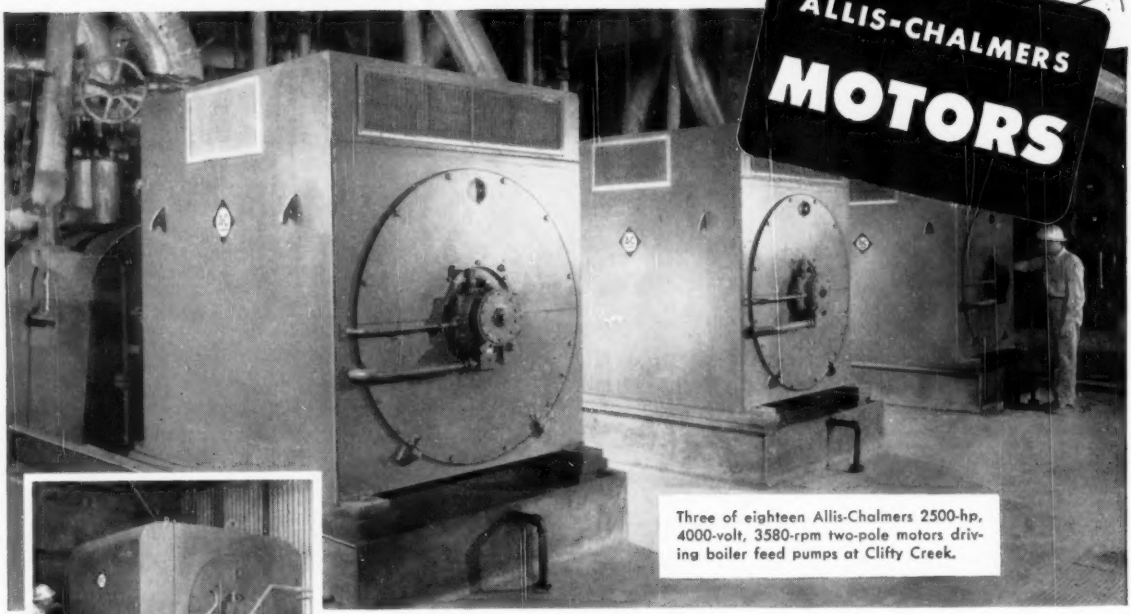
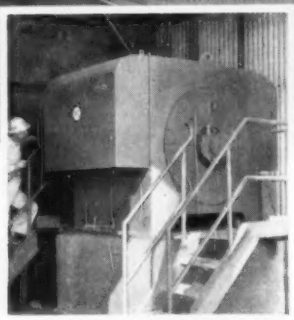
Furnishing Major Auxiliary Drive Power

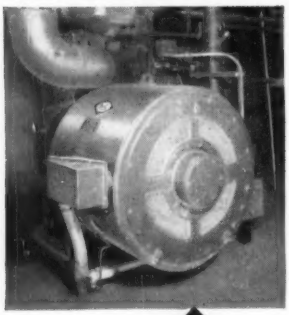
at Indiana-Kentucky Electric Corporation's Clifty Creek Plant



Three of eighteen Allis-Chalmers 2500-hp, 4000-volt, 3580-rpm two-pole motors driving boiler feed pumps at Clifty Creek.



Rooftop installation of Allis-Chalmers 1500-hp, 4000-volt, 1185-rpm weather-protected motors. This is one of twelve Allis-Chalmers motors giving dependable service driving forced-draft fans at this modern new plant.



Allis-Chalmers 250-hp flange-mounted motor driving plant air compressor. This unusually economical mounting method for such a large motor can be attributed to Allis-Chalmers experience in motor applications throughout the electric power industry.

A wide variety of Allis-Chalmers motors furnish most of the major auxiliary drive power at Clifty Creek Plant near Madison, Indiana. Allis-Chalmers motors are driving plant air compressors, coal handling equipment, forced-draft fans, boiler feed pumps and many other pumps.

The Allis-Chalmers motors at this Indiana-Kentucky Electric Corporation installation are just a few of the complete line of motors Allis-Chalmers builds for power plant service. Contact the Allis-Chalmers district office in your area, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for complete information. A-4956

Now, You Can Get Even Greater Winding Protection with SILCO-FLEX

all-silicone-rubber motor insulation. Available only on Allis-Chalmers motors — in many of the larger sizes. Ask your A-C representative for the facts about this revolutionary new insulation system.

Silco-Flex is an Allis-Chalmers trademark.

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ALLIS-CHALMERS

ELECTRICAL ENGINEERING

DECEMBER 1956
Vol. 75, No. 12

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Contents

New Requirements on Education Imposed by Advancing Technology *J. R. Killian*

In an address, the president of MIT discusses the ever-increasing obligations of the university in meeting the needs of the age of technology 1061

Electromagnetic Ball Conveyor *G. H. Strong*

Description of a conveyor designed to transport neutron-absorbing balls for controlling reactivity in cases of rapid shutdown of a power reactor 1064

Television—A Military Intelligence and Communications Medium *Norman Gray, J. C. Jangarathis*

A summary of some of the proposed applications for military television in combat, including field experience with two of the units 1069

Principles of Programming *J. B. Ward*

Hypothetical sample computers illustrate principles of programming and the type of thinking necessary to utilize automatic digital computers 1078

A Control System for Research-Type Nuclear Reactors *E. T. Davis, V. S. Underkoffler, R. N. Brey*

A flexible, low cost industrial servo system which is used to provide control for nuclear research reactors is described 1086

Isolated Phase Telescoping Bus Duct *S. C. Killian, K. Boyajian*

New type minimum-gasket bus ducts and the electrical problems which are associated with this new design are described in detail 1094

Power Generation and Distribution at Air Defense Computing Centers *J. J. Gano*

The diesel-power generation and distribution system described provides uninterrupted power for electronic computers at weapons direction centers 1098

Epoxy Resin Casting of Dry-Type High-Voltage Components *C. W. Park*

The numerous advantages of epoxy resin casting are outlined, together with a description of the techniques used in molding and optimum shapes 1104

CONTENTS CONTINUED

THE COVER: Optical tracker watches objects in color and photographs them simultaneously in black and white even when more than 300 miles away. Story on page 1136.

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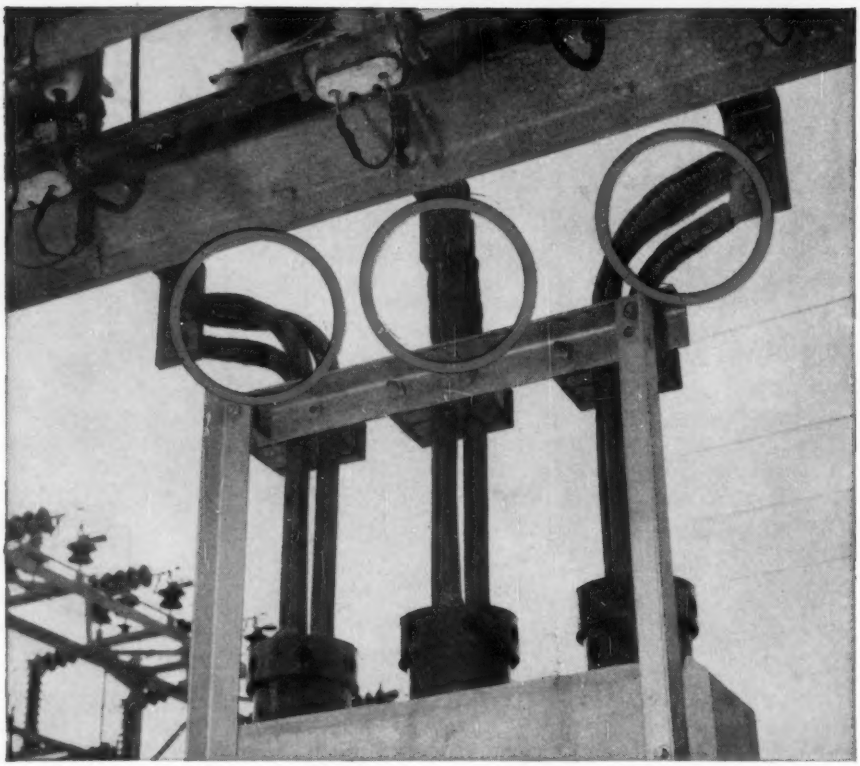

Simplicity of terminating Okolite-Okoprene unshielded 5kv cable is evident in this photograph of the Pearl River Substation feeder circuits of the Rockland Light and Power Company.

Why Okolite-Okoprene
UNSHIELDED 5KV CABLE
simplifies installation procedure

Ease of termination is an important factor in the increasing choice of unshielded Okolite-Okoprene cable for 5kv distribution circuits. Rockland Light and Power Company specified 500 MCM Okolite-Okoprene unshielded 5kv cable for the 4160-volt feeder circuits in its Pearl River Substation. Terminal stress cones and ground straps are eliminated by the unshielded construction—only a simple, easy-to-apply wrapping of Okoprene tape is needed.

Two electrical characteristics of the Okoprene sheath eliminate the need for a shielding tape, even at 5kv. First, Okoprene's excellent ozone resistance prevents cutting by corona developed on adjacent apparatus. Second, Okoprene's high surface resistivity prevents heavy longitudinal drainage currents, which might cause the sheath to burn at the point where the electrostatic charge flows to ground.

Okonite's new 128-page Bulletin EG-1085 gives complete information on Okolite-Okoprene rubber-insulated cable in the voltage range from 0 to 5000 volts. This bulletin includes detailed cable construction features, engineering information, installation and handling techniques, instructions for splicing and terminating. Never before has all this information been compiled in one book. Write for it to The Okonite Company, Passaic, New Jersey.

Available with either copper or aluminum conductors

OKONITE OKONITE SINCE 1878 ***insulated cables***

2759

Contents Continued . . .

Technical Paper Digests

Microwave System for Southern Colorado Power Company — *G. D. Perry, Jr., Eugene Langone* 1075
Motor for Atomic Reactor Rod Mechanism Drive — *D. A. Guerdan* 1076
Rating and Application of Semiconductor Rectifiers — *E. W. Gutzwiller* 1077
Solving Thermal-Circuit Problems with Computers — *A. E. Johnson* 1084
A New 115 Kv 1,000 Mva Gas Filler Circuit Breaker — *C. F. Cromer, R. E. Friedrich* 1085
In-Service Winding Temperature Measurement — *P. K. Pavlides* 1091
Nonlinear Control System Response to Random Signals — *P. N. Nikiforuk* 1092
Synchronization by Means of Multiplier Phototubes — *Leo Levi* 1093
Variably Damped Servomechanisms — *L. Schieber* 1103

News Index

Institute Activities 1107
49 Technical Committees Plan for 101 Winter General Meetings Sessions 1107
New Attendance Record Set at AIEE Fall General Meeting 1108
AIEE Future Meetings 1111
Board of Directors Fall Meeting Held in Chicago, Ill., October 5, 1956 1112
Engineering Societies Present Award to C. F. Kettering 1114
Forum of Technical Committee Chairmen Held During AIEE Fall General Meeting 1115
Conference Papers Open for Discussion 1120
Committee Activities 1123
AIEE Personalities 1125
Obituaries 1125
Membership 1126
AIEE Section and Student Branch Meetings 1955–56 1127
Electrical Engineering Education 1129
AIEE in Union College 1129
RPI Plans for 80 Per Cent Increase in Undergraduate Enrollment 1129
University of Kansas Is Host to Tau Beta Pi National Convention 1130
AIEE-IRE Student Branch at Texas Tech Holds Initial Meeting 1130
An Electrical Engineer in Manufacturing 1131
University of Missouri Network Analyzer 1133
Of Current Interest 1134
Transatlantic Laying of Telephone Cable System Completed 1134
Giant Tracker Watches Missiles That Are 300 Miles Away 1136
Future Meetings of Other Societies 1137
Mauna Loa Observatory To Study Atmospheric Phenomena 1139
Largest Man-Made Crystals Are Displayed 1141
Fuel Cell Studied at New Laboratories 1143
Free Flight Research Tool Gathers Hypersonic Speeds Data 1144
United Nations Facts and Recommendations 1146
Letters to the Editor 1147
New Books 1148
Pamphlets 1150
Industrial Notes 14A
New Products 20A
Trade Literature 40A
Index to Advertisers 112A

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JAMES E. DAVIS CHIEF ELECTRICIAN NORTHWESTERN GLASS CO.

"Our Production schedule was frequently disrupted by needless shutdowns on a line of motors . . *until we changed to Fusetron Fuses*"

James E. Davis.
CHIEF ELECTRICIAN, NORTHWESTERN GLASS COMPANY
SEATTLE, WASHINGTON

"Ordinary 500 amp. renewable fuses were blowing frequently in a 1000 amp. switch that controls a line of motors ranging in sizes up to 150 hp.

"We work on a tight production schedule, so these shutdowns with men and motors standing idle were costing us a considerable amount of money and trouble.

"As chief electrician, the problem was 'thrown in my lap'.

"A study of the situation indicated that harmless surges were causing the fuses to blow.

"We figured that the long time-lag of Fusetron dual-element fuses might correct the trouble.

"They were installed in 1953 and the original Fusetron fuses are still in service.

"We think this is quite a record because the switch is loaded to capacity 24 hours a day 7 days a week, only Christmas and July 4th excepted."

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A fuse link combined with a thermal cutout - the result, a fuse with tremendous time-lag and much less electrical resistance and an interrupting rating in excess of 100,000 amps.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses. FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 amperes, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

Write for bulletin FIS.

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MACHINE OPERATOR

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They have unlimited interrupting capacity to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

FUSETRON DUAL-ELEMENT FUSES DO MORE THAN ELIMINATE DOWN PERIODS CAUSED BY NEEDLESS BLOWS . . .

They Provide 10 Point Protection . . . .

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.
3. Protect against needless blows caused by harmless overloads.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
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7. Give DOUBLE burnout protection to large motors — without extra cost.
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9. Make protection of small motors simple and inexpensive.
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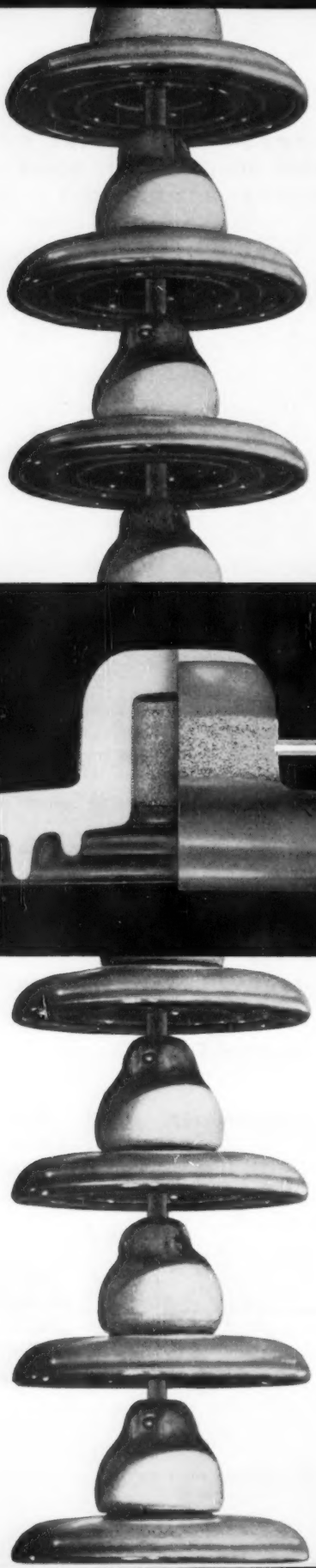

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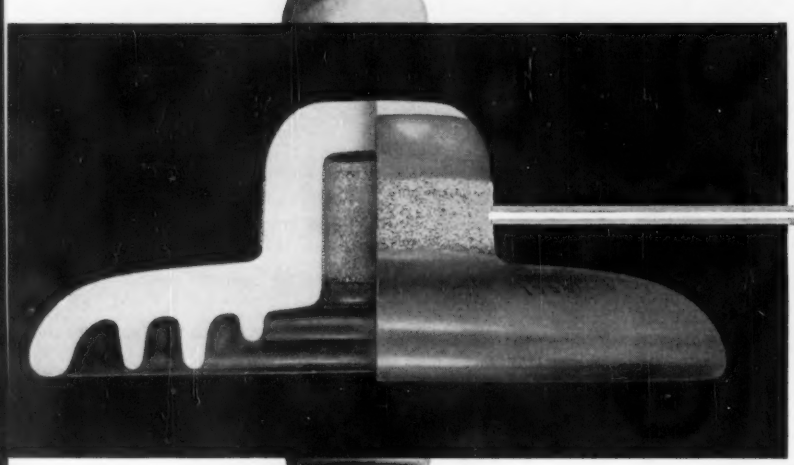

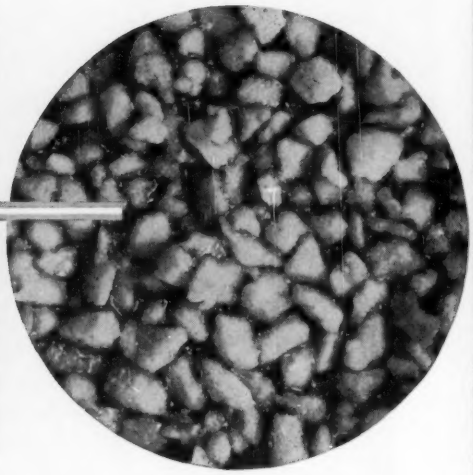

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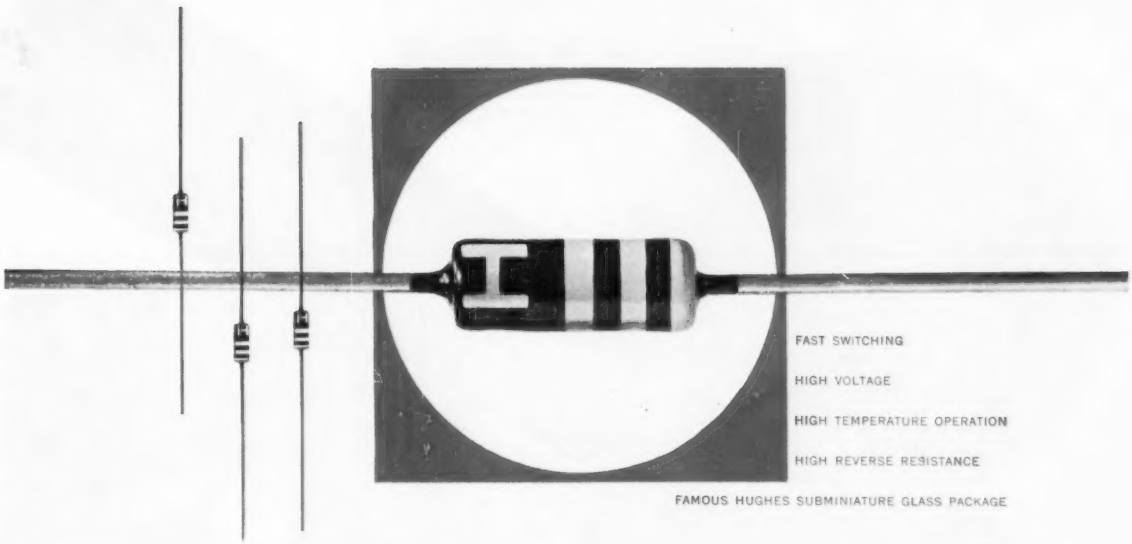
Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp



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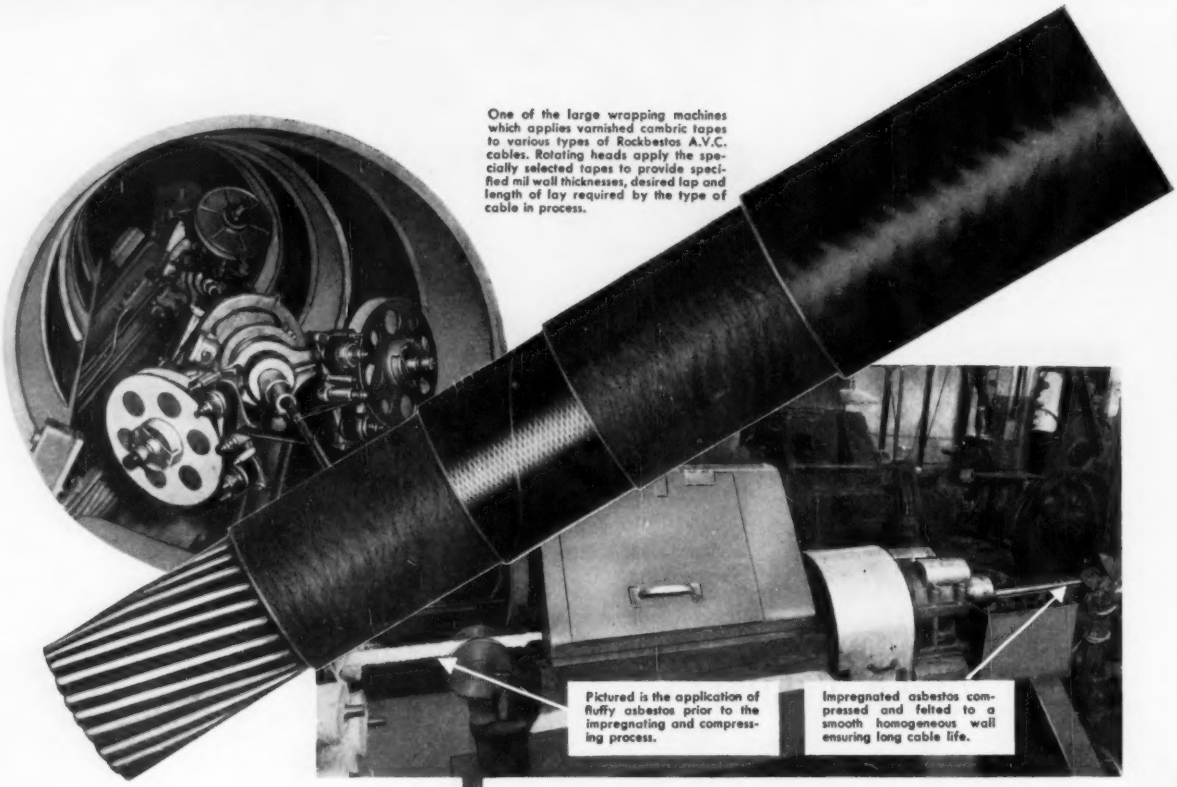

One of the large wrapping machines which applies varnished cambric tapes to various types of Rockbestos A.V.C. cables. Rotating heads apply the specially selected tapes to provide specified mil wall thicknesses, desired lap and length of lay required by the type of cable in process.

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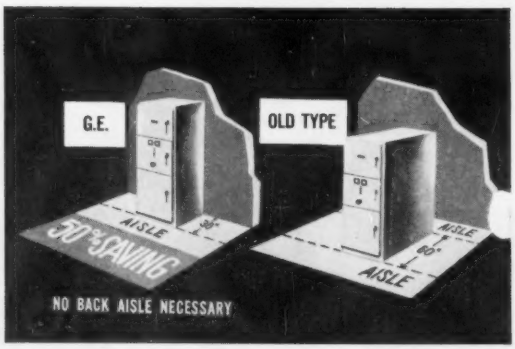
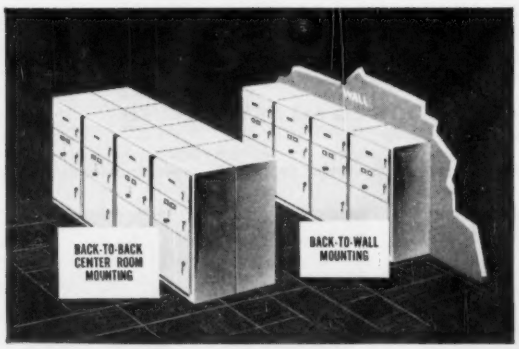


ELIMINATION OF BACK AISLE plus 30-inch-deep Limitamp control units results in floor space savings of 50%.



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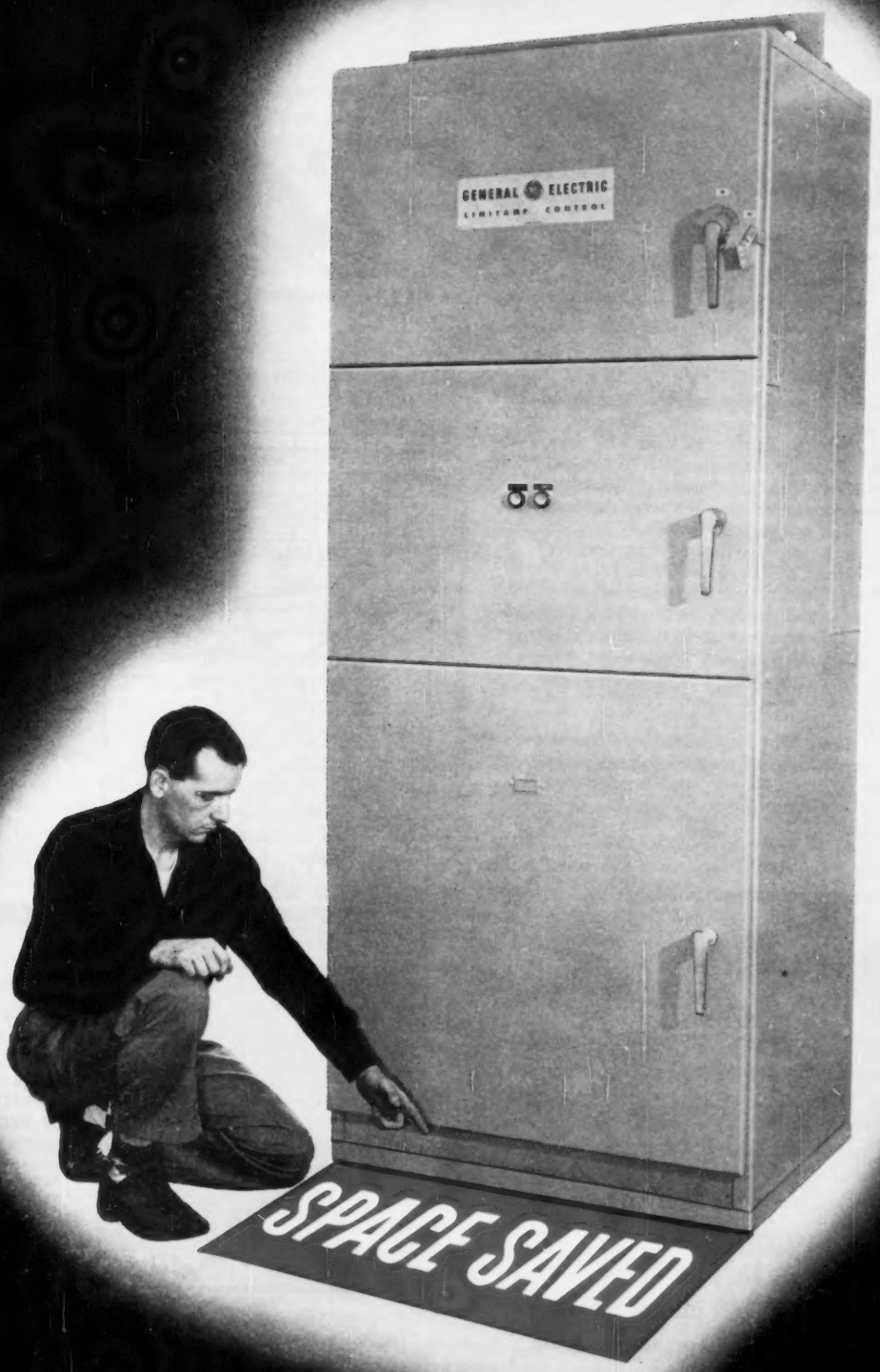

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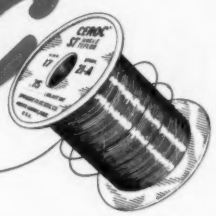

CEROC is an extremely thin and flexible *ceramic* insulation deposited on copper wire. *This ceramic base insulation is unaffected by extremely high temperatures.* Thus, in combination with silicone or Teflon overlays, Ceroc insulations permit much higher continuous operating temperatures than are possible with ordinary insulations.

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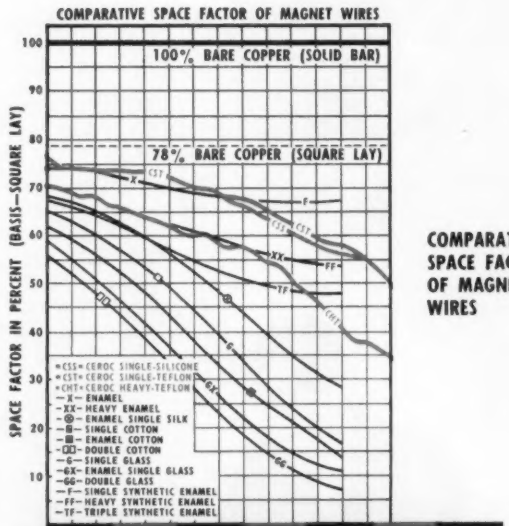

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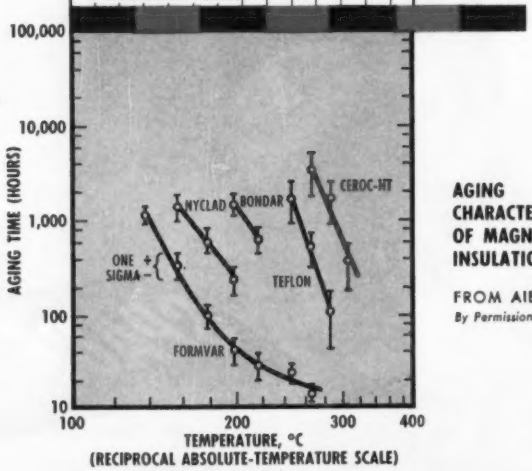

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New Requirements Imposed on Education by Advancing Technology

J. R. KILLIAN

On the dedication of a new laboratory of the Union Carbide and Carbon Company, the president of Massachusetts Institute of Technology states that expanding industrial research bears a symbiotic relationship to our universities. As American industry, in response to an onrushing technology, grows more complex, our universities find themselves with new duties—the degree of success will be seen in the future.

TO DISCOVER the major new obligations that are falling upon our educational system, one does not have to undertake a research project. We know now that one of the great social and economic inequities of our time is the underprivileged status of the teacher, with a resultant shortage of teachers that admits of no real rectification for nearly a decade. We know that our school population has outrun not only the capacity of our teaching corps and of our school buildings, but also the diminishing share of the national income allotted to our total educational system. We now know that in an age of technology, the mathematics upon which technology must rest, by some curious distortion of educational judgment, has come to be too widely treated as an unwelcome country cousin in the school curriculum. We know that the educated professional talent to do the skilled work of our society is in short supply, as dramatized by the current shortage of scientists and engineers, and that we have maldistribution and malnutrition in the totality of professional and graduate education in the United States, again as pointed up by the inadequate output, both quantitatively and qualitatively, of scientists, engineers, and physicians. We know that our international responsibilities in the commonwealth of free nations, our expanding foreign business, and the relentless necessities of a divided world require us to educate, as we have never done before, for the demanding requirements of foreign service, including not only language proficiency, but also the perceptive understanding of foreign peoples.

These conditions, deficiencies, and requirements of education in the United States are coming to be more widely understood, as illustrated by the allusions to some of them in the oratory of our recent political conventions. What is not so clearly understood or emphasized in the current welter of discussion about education—what we tend to back away from in this century of the common man—is uncommonness, the issue of quality and excellence that is the common denominator of all our educational problems; the problem of how we achieve education, as we must, for the masses of our people and yet find ways to demass it so that the dignity and talents of the individual of high, as well as average, gifts can most fully be cultivated.

In the special setting of these dedication ceremonies, of special relevance, consider the following four aspects of scientific and engineering research and education, which bear upon this issue of quality and on the nation's urgent need to maintain its technological zest and audacity.

GRADUATE STUDY

FIRST, consider the need for a more advanced level of engineering education. So far, our chief reliance has been on an undergraduate professional preparation—a system which universally has not risen above the training of technicians. Although there will long continue to be an appropriate and essential place for the really professional 4-year undergraduate engineering program, it must be supplemented by expanded provision for graduate study. Many industrial companies have been ahead of the colleges in recognizing the need for engineers of such higher attainments. Consequently, they have set up training programs of their own to carry their engineers to more advanced levels than these young men achieved in their 4-year undergraduate engineering education. To the extent that industry has had to do this because of the inadequacy of the preparation of their engineers in the colleges, they have had to make up for the defaults of education. If more engineering school graduates could be left in the colleges to continue on into graduate school and if we had the graduate school capacity to handle them, it would be more appropriate and advantageous in the long run for these men to receive their advanced training in college rather than in industry. The engineer, no less than the scientist, can benefit from advanced professional study in a university atmosphere of uncommitted research. The maintenance of our technological advance in the United States will be more certain if we can find ways to encourage the top graduates of our 4-year engineering schools to go on to graduate study to gain a greater insight into engineering science and of the mathematical analytical power necessary for the mastery of the more profound and theoretical aspects of engineering.

As we encourage more of our Grade A engineering students to extend their education into the graduate years, we have good reason at the same time to increase the number of engineering schools where the curricula include a large content of basic science and mathematics, with less emphasis on contemporary practice. We need more programs that are less vocationalized at the undergraduate level and

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Essentially full text of a dedication ceremonies address given at National Carbon Division, Union Carbide and Carbon Corporation, Parma, Ohio, September 18, 1956.

J. R. Killian is president of Massachusetts Institute of Technology, Cambridge, Mass.

fundamental enough in their basic science and humanities to educate a new breed of engineer more adaptable to our rapidly advancing technology.

ACTIVITIES

THE SECOND IMPORTANT REQUIREMENT for insuring that our universities do their part in maintaining and augmenting our technological vitality should be considered. The university and institute of technology must continue to be, in fact and reputation, the principal recognized homes of free and unconsigned research and scholarship and all institutions occupying the domain of science—industry, Government, and education—share responsibility for maintaining interest in this specialized function of the university.

At present, university faculties are subject to tempting and often compelling appeals to undertake research or other activities which are outside the area of uncommitted research and teaching. It cannot be argued that they should avoid these practical, developmental, or immediate applications of science; the urgencies and exigencies of our defense and other needs will not permit ignoring or avoiding them. It should be stressed to the nation the importance of our not permitting applied and practical scientific activities to so warp our total effort that pure research is retarded or diminished and the status of the uncommitted scholar–teacher is weakened. The best defense against the undercutting of basic research is to hold fast to the university ideal of an environment where discovery and learning go hand in hand, each abetting the other. We need to recognize and protect this highly specialized function of the university.

Although it should not be argued that all pure research should be concentrated in the universities, it should be urged that we must not disperse our pure research so much that the university no longer is its chief home. In recent decades, we have witnessed the establishment and growth of various forms of highly useful research institutions of the noneducational nonindustrial kind which have basic research as one of their functions, if not their primary activity. Some of these institutions are amply financed and are able to offer compensation to scholars substantially higher than that available in the universities. If we permit our universities to become less attractive environments than these other kinds of research institutions, then we face the certain prospect of handicapping the education of new talent in the sciences. We can sympathize with Ambassador Conant's strong statement that "The extent that fundamental research is in progress in institutes divorced from teaching, the development of talent is impeded." The education of our future scientists and engineers will fluorish best when it can be conducted in an environment where there is interplay and interdependence between teaching and research, and where both are conducted in an environment where scholars are free to follow their own bent and where the prospering of disinterested curiosity is subject to minimum distractions.

NEW PATTERNS OF LIAISON

THE IMPORTANCE should be realized of both industry and the universities seeking new patterns of liaison between the fundamental research activities of the university and the more directed committed research of industry, so that cross-fertilization may be encouraged while recognizing and protecting the specialized function of each. It is urgently important to de-emphasize the support of projects and to enlarge the support of men and institutions, so that the researchers in our universities can have greater freedom to be uncommitted to externally imposed objectives.

Another aspect of the teaching and research activities of the universities warrants remedial action at the present time. Some fields of science and engineering are drawing inadequate numbers of students and insufficient research support. Too few students, for example, are now studying to become metallurgists, biologists, geologists, aeronautical engineers, mathematicians, and chemists. There is also inadequate support for pure research in some of these fields. Chemistry, for example, has fallen behind such sciences as physics and biology in attracting or receiving the funds it needs, with the result that graduate study in chemistry is handicapped. The profession of chemistry is about five times the size of the profession of physics, yet physics is now more amply supported. The chemical industry far exceeds all other industries in the United States in the amount it expends for basic research in its own laboratories. It is an anomaly that chemistry research in the universities has declined, relative to several other fields of science. The universities, industry, and foundations all have a responsibility to find fuller support for this important and expanding field, if the over-all progress of technology is not to falter.

While our American universities now show great vitality and progress, we must not become complacent about their future, especially in a field so rapidly changing as science or engineering.

The universities have not always maintained their intellectual vitality or been the principal centers of creative scholarship. We need only recall the strange retrogression of the American college in the first 40 years or so of the last century or the general decline of the European universities in the 16th, 17th, and 18th centuries. Some of the great European creative minds of this period, as the historian, Paul Farmer, reported in a recent paper, did their work outside of the universities, even declining, as did Leibnitz, to be associated with a university. Such great scholars as Bacon, Descartes, Locke, Boyle, and Lavoisier had slight if any connections with universities, and much of the intellectual activity of the Age of Enlightenment occurred outside the academic environment.

Universities did not educate any significant number of scholars in the sciences until they brought together scholars with a consuming interest in expanding the boundaries of some discipline and achieved that coalition of advanced teaching and research, which is essential for the effective education of professional scientists and engineers.

Now that we have evolved this remarkable intellectual mechanism for generating new science and serving as the nursery of new scientists, we must recognize and protect its specialized function in the interest of maintaining the vitality of applied science in industry and elsewhere.

OPPORTUNITY

FINALLY, consider one other requirement of current importance which rests upon education, if it is to keep up with the needs of our advancing industrial technology. We need to make better provision for our gifted young people so they may be given maximum opportunity and freedom to realize their full potential. We need the teachers who have the perception to identify and encourage them early—in grammar school, preferably, but certainly in high school. Two thirds of our top-ranking high school graduates never get a college degree, either through lack of means or lack of motivation, and we can ill afford this loss. The lock step procedures of both high school and college are not conducive to the surest growth of this exceptional talent, and we need to recognize the importance of programs and institutions differentiated more in accord with intellectual competence. When they go to college, the ablest of our youth can usually benefit most from going to institutions where there are other comparably able students and where they are really challenged by competition and requirements.

There seems to be no conflict between making special provision for the gifted in our educational system and, at the same time, maintaining opportunities for all of our young people to get an education commensurate with their abilities. So far, in the development in our great system of public education, we have given first attention to providing educational opportunity for all of our young people regardless of their means or their abilities. We must continue to do this, but the next great step should be to provide motivation, reward, and opportunity for those of more than average gifts.

Today, research is a glamour word in the American industrial lexicon. Of our national research expenditures of $5 billion or so, industry is responsible for two thirds and industry's investment in research still grows. If this huge investment is to pay off, as indeed industrial research has in the past, there must be a steady flow of first-rate minds into our industrial laboratories. The productivity of this vast research effort and the nation's confidence in it will depend on our educational system's producing the increased numbers of creative and talented personnel the growing research program requires. If industry is to have the personnel to man its multiplying laboratories and is to have the talent to handle the increasing operational complexities imposed by modern technology, our educational system must grow and improve in proportion to the growth and advance of industry. In fact, it should be a step ahead! For these reasons the educational problems and requirements outlined seem appropriate for discussion on this occasion. If we can solve them wisely, industry need have no fear for its technological future or the nation any worry about being outpaced in its intellectual achievement.

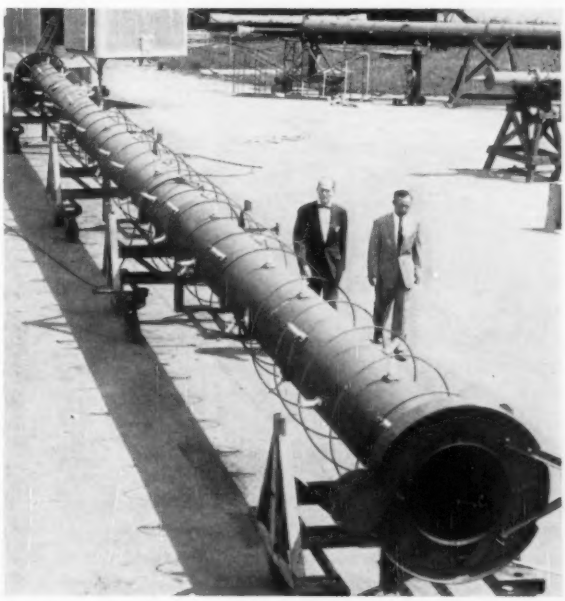
VHF Television Station Broadcast Antenna

Somewhat resembling a long steel smokestack that is wrapped in a wire coil, this giant vhf helical television-station broadcast antenna was recently designed, not for smoke signals, but in order to transmit high-powered television signal patterns.

Developed by the General Electric Company's broadcast engineers at the Company's Electronics Park at Syracuse, N. Y., the rugged antenna shown at the right is the simplest, as well as the largest of its type that has ever been manufactured.

Principal advantages of the new 3-bay helical antenna, General Electric broadcast engineers say, is its simplified design. For ease of maintenance, it requires but 10 feed points, or electrical connections for power and de-icing, as compared to 200 that are usually required on comparable "batwing" antennas now in widespread use by television stations.

The 7,700-pound 80-foot-long antenna was trundled out to the electronics test area recently to signal the opening of National Television Week in the Syracuse area. When in actual use by a television station, the antenna will be mounted atop a high tower.



Electromagnetic Ball Conveyor

GRANT H. STRONG
ASSOCIATE MEMBER AIEE

In the operation of a nuclear power reactor, a means of rapid shutdown is required to prevent a "runaway" in case of equipment malfunction. One scheme involves the use of balls having a neutron-absorbing element to control the reactivity. An apparatus has been devised to transport the radioactive boron steel control balls through a stainless-steel tube. Movement through the tube is effected by traveling magnetic waves which pull clusters of balls within them as they progress linearly through the tubes.

THE ADVENT of the atomic age has required the development of completely new types of apparatus for handling of radioactive materials and controlling the spread of contamination. Various types of equipment for performing these functions are constantly being developed.

A nuclear reactor which is supplying power for an electrical generating plant must have some means of control so as to be able to match the nuclear power output to the fluctuating demands of the electrical system. For safety reasons, some method of rapid reactor shutdown also is required to prevent a nuclear reaction "runaway" in case of equipment malfunction. Generally, the apparatus for effecting rapid shutdown, or "scram" as it is called, is completely different and separate from the apparatus used to regulate power level.

There are two reasons for this separation. First, equipment which is used for effecting slow accurate motion, such as that used for regulation, is not easily adaptable to the rapid movement required for a scram. Second, if the power-regulating device were also used for rapid shutdown, the reactor would operate entirely out of control and could endanger human life if this one device failed. In some instances, one regulating apparatus and two separate shutdown apparatus are used to achieve a high degree of safety.

Reactor control schemes include the use of gas, rods, liquids, and balls or shot. Each of these media contains a neutron-absorbing element, or poison, which controls reactivity according to the amount of poison inserted into the reactor. Gas, rods, and liquids are most frequently used for regulation, whereas rods and balls are used for scram operations.

Most of the devices used for reactor control are expensive, and ways are continually being sought to reduce such expense to bring reactor power generation costs more in line with the costs of present conventional power generation systems.

A method has been devised for effecting rapid reactor shutdown in graphite moderated power reactors by use of boron steel balls. After the balls are dropped into the reactor to shut it down and then are drained out to allow it to start up, it is necessary that they be returned to the top of the reactor. An electromagnetic ball conveyor, called the "electroveyor" has been developed to perform this operation. Detailed design of the prototype electroveyor was done at the General Engineering Laboratory of General Electric Company in co-operation with the Hanford Atomic Products Operation.

A design was developed and a prototype built, but the conveyor has not been used, as yet, on a power reactor. The electroveyor was designed for use on a power reactor of the type described in paper *UN492* presented at the Geneva Conference. Design and performance of the prototype is described in this article.

The electroveyor consists of a nonmagnetic stainless-steel tube with a $2^1/_4$ inch inside diameter, and is surrounded by electromagnetic coils connected to produce successive north and south poles in the axial direction. By energizing groups of coils progressively, traveling magnetic waves are produced which pull the balls through the tube in synchronism with each magnetic wave.

To produce the low-frequency magnetic sine waves, a specially designed sine potentiometer was constructed. The signal generated by the potentiometer is subsequently fed to the control fields of amplidynes* for power amplification before application at the conveyor coils.

Other auxiliary apparatus include special valves for directing and controlling the flow of balls and an air-jet system for supplementary cooling of the coils for use when thermally hot balls are carried in the tube. Steel balls 3/8 inch in diameter have been transported at a rate of over 600 pounds per minute. Delivery of balls can be accomplished both vertically and horizontally.

REQUIREMENTS

AN EQUIPMENT WAS REQUIRED which would transport 3/8-inch magnetic steel balls more than 170 feet horizontally and vertically. Transport had to exceed 500 pounds of

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The author wishes to express his appreciation to J. H. Barnwell and R. B. Pease of General Engineering Laboratory, Schenectady, N. Y., for background and source material; and to W. J. Dowis, E. P. Peabody, and I. M. A. Garcia of the Hanford Atomic Products Operation, Richland, Wash., for review and comments.

* Registered trade mark of the General Electric Company.

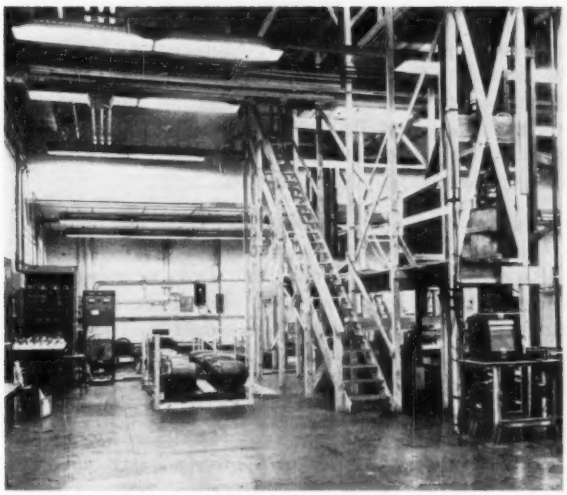

Fig. 1. Electroveyor. Vertical riser coils are just to right of stairs, amplidynes in left foreground.

balls per minute. It was desirable that the conveyor incorporate few or no moving parts, although no such limitation was placed on other auxiliary power apparatus which could be located remotely from the conveyor.

The prevention of operation by permanent jamming of balls could not be permitted, especially following any temporary power failure. All components of the system were to be capable of operating continuously, although in actual use it was anticipated that the conveyor would probably never operate for more than a few hours at a time.

It was essential that the conveyor be designed to require little or no maintenance of the tube and coils over a 20-year period. However, it was necessary that the conveyor be constructed in removable sections, so that any section which failed in operation could be replaced within one hour.

Design was complicated by the requirements that the conveyor must be watertight, airtight, and able to handle material at temperatures exceeding 650 F. It was also desirable that the conveying system be as small as practical because of installation space limitations.

PRELIMINARY INVESTIGATIONS

SEVERAL DIFFERENT METHODS of transporting balls magnetically were considered. Among the magnetic systems considered were: (a) linear motor, (b) tapered solenoid, and (c) moving field solenoid. A small working model of each of these approaches was constructed for study purposes.

Linear Motor. This conveyor is essentially a motor stator cut parallel to the axis and laid out flat. A paramagnetic plate (or similar stator) is placed over the primary stator, leaving a 1/2-inch air gap for passage of balls in formed channels. The winding is similar to an ordinary 3-phase motor. Balls are propelled along the narrow straight channels between the stator sides by induction action. A sorting device is required to reduce a mass of balls to one layer thickness before introduction to the conveyor. Difficulty in sorting balls and in the high expense required to provide a long laminated stator were among the factors against proceeding on this type of design.

Tapered Solenoid. A d-c solenoid with a cylindrical core but wound conically outside produces a magnetic field with a magnetic center near the large-diameter end. Balls of magnetic material placed near the small-diameter end tend to move through the hole in the center of the coil to the magnetic center near the opposite end. Auxiliary apparatus is required to extract the balls from the latter end. The small model operated successfully raising balls to a point near the top of the top-heavy conical-shaped coil. However, a coil would be impractical if constructed in lengths of about 100 feet. The high cost of copper required to make such a coil eliminated this proposal.

Moving Field Solenoid. Laboratory coils approximately 1 foot in outside diameter and 6 inches long were arranged along a 3-inch tube formed in the shape of a "C" approximately 6 feet in height. Balls were fed in at the bottom, and when the coils were energized one at a time in sequence, the traveling magnetic field pulled the balls through the tube to eject them at the top.

Each traveling wave was of like polarity, and trouble was immediately encountered with the balls sticking at the top before being ejected. Stray magnetic fields from adjacent coils prevented the balls from releasing properly. To obviate this problem, it was decided to alternate the polarities of the magnetic waves so that adjacent ball clusters and magnetic fields would repel each other. This arrangement also helped prevent balls from dropping from one cluster to the next lower cluster in vertical runs. Op-

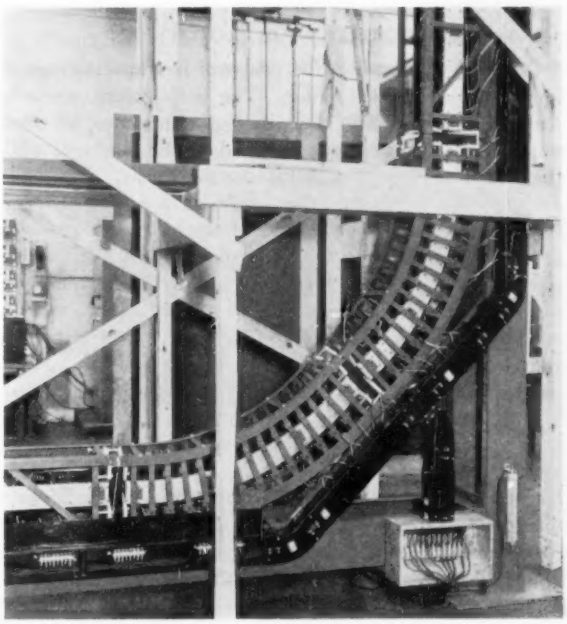

Fig. 2. Electroveyor corner sections.

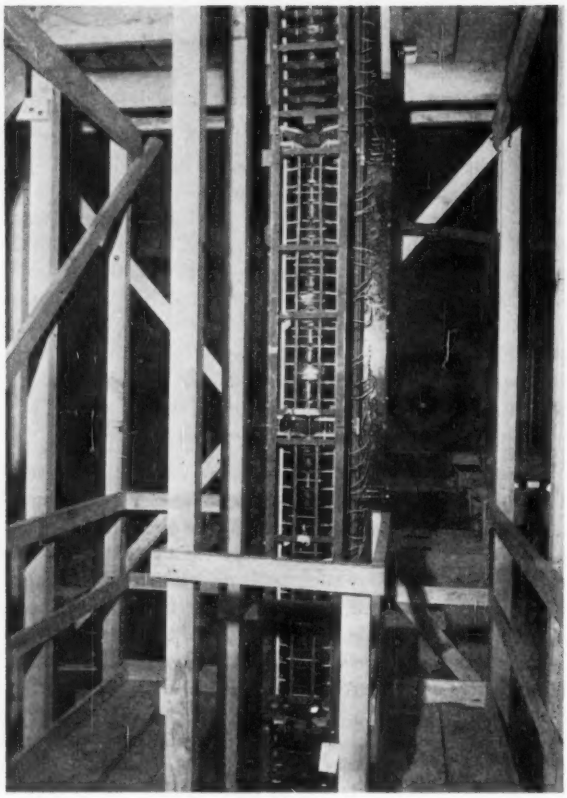

Fig. 3. Electroveyor vertical lift.

eration was successful and demonstrated the superiority of this approach over the other models tested.

DESCRIPTION OF PROTOTYPE

Conveyor. Essentially, the conveyor is a special type of low-frequency linear motor. The coils which encircle the tube correspond to the windings of a motor, whereas several coils comprising a solenoid of the conveyor correspond to a phase of a multiphase a-c motor. The balls are comparable to the salient poles of a reluctance-type synchronous machine. As the flux sine wave revolves around a motor stator "pulling" the rotor with it, so also does the flux sine wave progress axially along the tube pulling the balls with it.

The prototype is shaped in the form of a "U" lying on its right side as indicated in Fig. 1. It is 20 feet high and 20 feet long. Two standard types of 4-foot sections assembled end to end make up the conveyor proper. One type is used for straight runs and another type, forming a circular angle of 45 degrees, is used for corners. Two complete corner sections and two partial straight sections can be seen in Fig. 2. Figs. 3 and 4 show vertical and top horizontal runs, respectively.

Each section consists first of a schedule-*40* stainless steel tube $2^1/_4$ inches in diameter and 4-feet long. Surrounding this tube 16 coils are placed end on end, each 5 inches in outside diameter and 2 inches thick, spaced on 3-inch centers. Flux strength within the tube is enhanced by iron cladding. Field iron in rectangular strips is used along two opposite sides of the coils with pole pieces placed in coil interstices and bolted to the rectangular strips. Other appurtenances include wiring gutters and air-cooling jets. All of the foregoing components are supported by rectangular steel framing and beams.

Power Supply. The type of power supply was influenced considerably by theoretical calculations which established the manner in which the magnetic waves or pulses would carry the balls through the tube. The results of these calculations indicated that the balls would tend to form in clumps under the influence of the solenoid fields. Multiphase power with several phases was desirable to provide for a smooth even movement of the traveling magnetic wave. Four-phase power was considered to be superior to 3-phase power because the ball clusters would repel each other to a greater degree. Increasing the number of phases above four introduced other problems, especially that of greater expense of construction.

Considerable flexibility was required of the power supply with the prototype conveyor. Inasmuch as the balls are carried in synchronism with the magnetic waves, the frequency had to be slow enough to lock a cluster of balls in synchronism as the wave passed by them. Conversely, delivery rate of balls is theoretically directly proportional to frequency. Also, flux strength would be controlled by coil voltage. Therefore, it was required that the power supply be capable of delivering variable voltage and variable frequency in order to establish optimum operating conditions.

Two major components were required in the power supply: (1) a sine-wave generator and (2) power amplifiers. Several types of power amplifiers were considered, in-

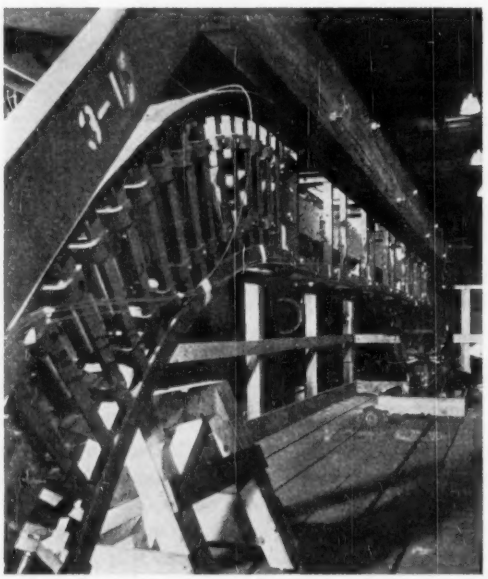

Fig. 4. Top horizontal run feeding into hoppers below.

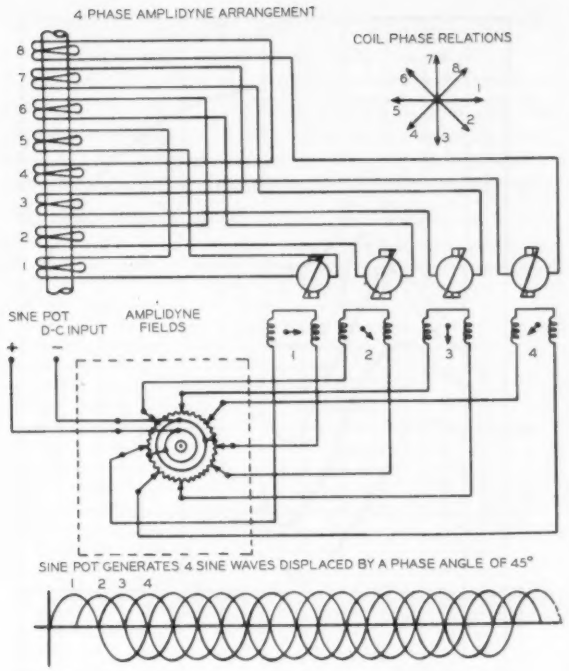
4 PHASE AMPLIDYNE ARRANGEMENT
COIL PHASE RELATIONS
SINE POT D-C INPUT
AMPLIDYNE FIELDS
SINE POT GENERATES 4 SINE WAVES DISPLACED BY A PHASE ANGLE OF 45°
1 2 3 4

Fig. 5. Four-phase sine potentiometer, circuit vectors, and sine wave plot, indicating phase displacements.

cluding (1) a selenium rectifier controlled by inductrols in the input circuit, (2) magnetic amplifiers, (3) power-tube rectifiers, (4) low-frequency a-c generator, and (5) adjustable d-c generators or amplidynes. The first two types were ruled out because either double capacity or elaborate switching would be required in order to take care of both the positive and negative loops of a sine wave, i.e., either a push-pull arrangement or double reversing switchgear would have to be provided. The possibility of developing a power-tube type of power supply was carefully considered, but eliminated because of the estimated time required by and the cost of such a development. Standard a-c and d-c motor–generator sets inherently have a slow time response to variable field excitation. Also, the magnitude of the sinusoidal field input required by a standard generator would present further complications, thus making these types of power supply undesirable. Amplidynes were selected because of their rapid response to input signals and their high-gain characteristics. Four amplidynes of 10 kw each were used. Four-phase alternating current amplification was accomplished with one machine assigned to each of the four phases. Although designed similar to a d-c machine, the amplidynes in test were capable of operating satisfactorily up to the required five cycles per second. Fig. 5 shows a schematic diagram of the 4-phase amplidyne circuit used.

Prime requirements of the sine-wave generator are (1) longevity and (2) freedom from troubles and breakdowns. One solution contemplated the use of two sine–cosine potentiometers mechanically connected in tandem but angularly displaced by 45 degrees, giving a total output of four phases. Several commercial sine potentiometers were investigated, but none was found to fit the requirements. The commercial sine potentiometers investigated were, for the most part, slide-wire devices with rather sharp sliding contacts. This results in excellent accuracy but short life and slow speed. Therefore, a decision was made to construct a 4-phase sine-wave potentiometer capable of supplying 0.3 ampere per phase at a voltage of 250 volts with a frequency range of 0 to 5 cycles per second.

The sine potentiometer used is based on the commutator-and-brush principle. A rotating element carrying 36 tapped resistors is mounted on bearings, with each resistor connected to a separate commutating bar. The generator is illustrated in Fig. 6. With the resistors adjusted to correspond to the amplitudes of a sine wave cut into 36 sections, and with a d-c voltage applied to one side of the resistors, the brush as it rotates around the commutating bars establishes a remarkably accurate sine-wave voltage. By using four brushes physically displaced by 90 degrees, a 4-phase signal is generated.

The power output of the sine wave generator was too low to be fed directly to the amplidyne fields, so an intermediate electronic amplifier was used on the prototype. Subsequent power supplies will likely utilize magnetic amplifiers for this stage, since burnout is negligible compared to electronic tubes.

Auxiliary Apparatus. A special cooling system is required to prevent the coils from overheating whenever balls at a temperature of approximately 650 F are carried through the tube. Air jets are arranged to blow cool compressed air into the annular space between each coil and the encircled tube. Therefore, little heat is transferred from the tube to the coil by conduction. The air stream also exerts a cooling effect on the inside coil surface, thus minimizing the small radiant heating effects of the tube.

Two hoppers and two special valves are arranged in a vertical alignment between the two open ends of the con-

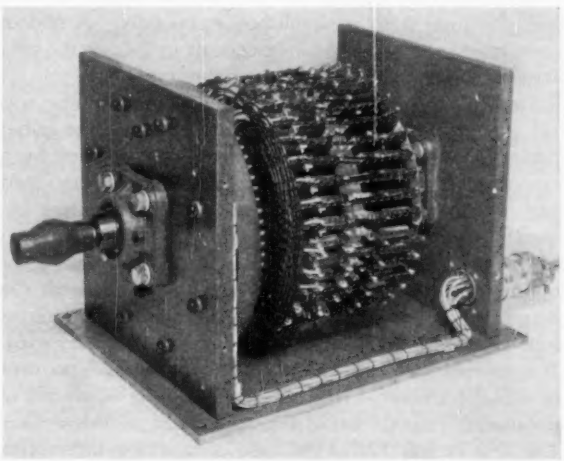

Fig. 6. Sine-wave generator.

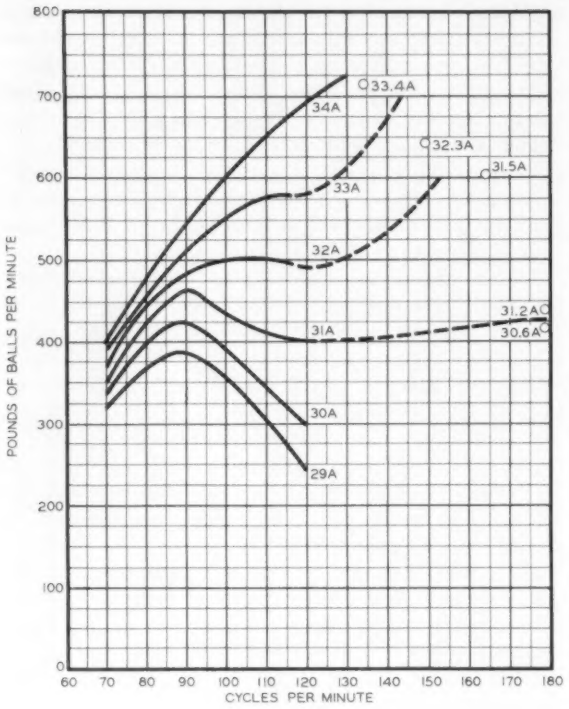

Fig. 7. Ball flow rate vs frequency, with rms current as a parameter.

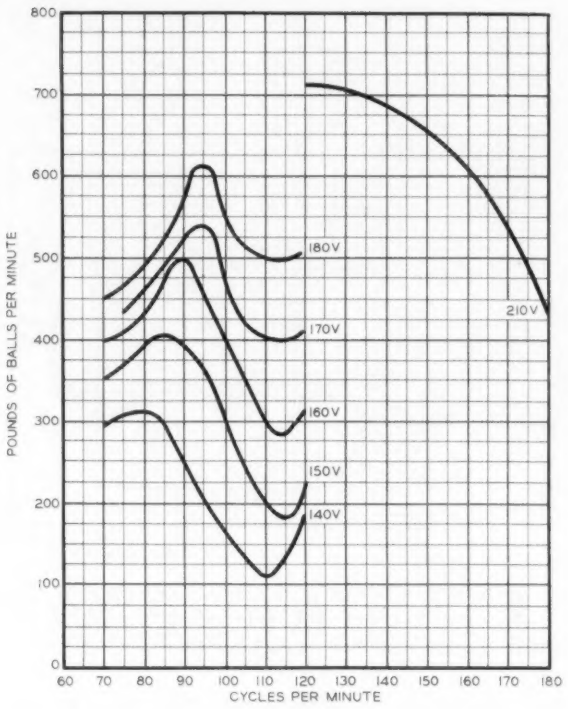

Fig. 8. Ball flow rate vs frequency, with rms voltage as a parameter.

veyor to hold, control, and direct the flow of balls through the system for testing purposes. A special 2-way spherical ball valve directs the flow of balls as they emerge from the top of the conveyor into either of two outlet pipes. One valve port feeds balls via a heater hopper, a storage hopper, and a cutoff ball valve to the lower entrance section. The second valve port feeds balls to another (special) entrance section in the center of the bottom run.

TEST RESULTS AND CONCLUSIONS

Construction and testing of a 60-foot electromagnetic ball conveyor were accomplished successfully. A 60-foot prototype was considered long enough to predict the performance of any length of conveyor of this type.

Delivery of over 600 pounds of balls per minute was achieved as indicated in Fig. 7, thus exceeding the initial design requirements. Delivery rate is determined by a combination of power input, operating frequency, and and conveyor tube diameter. An optimum operating frequency exists for a given power input in regard to maximum rate of delivery. A higher power input allows a higher optimum operating frequency which, in turn, speeds the flow of balls through the tube. This higher flow rate results in more pounds of balls per hour being transported. It is interesting to note that the drive efficiency is 5 per cent in actual transport. High efficiencies, however, are not of paramount importance in the application of this device. The real benefit lies in the ease of handling radioactive materials.

A study of Fig. 8 shows that the conveyor at maximum designed operation may have been operating on the threshold of greatly expanded delivery rates. With small increases in power, greatly increased delivery rates may be achieved. Thus, if future applications require greater delivery rates, over-all power applied to each conveyor coil will likely be increased.

The size of balls is not restricted to 3/8 inch in diameter. However, balls with diameters of less than 3/8 inch operate more satisfactorily than larger balls.

Making the conveyor tube watertight and airtight proved to be mostly a piping problem, after design arrangements were made to terminate the solenoid coils properly at the ends of each 4-foot section. Aluminum seals were used rather than rubber or plastic seals because of the high operating temperatures. An interesting test involved operating the conveyor with the tube filled with water. Although the delivery rate was slower, the clusters of balls continued to be pumped through the tube carrying streams of water with them, thus indicating that a surplus of power is provided over and above that required to pump the balls through the tube. However, it is not recommended that the ball conveyor be used as a water pump.

Air-jet cooling of the tube coils achieved good results. After the balls were heated to 650 F, the conveyor was operated continuously for one hour. Thermocouples strategically placed inside certain coils around the periphery of the prototype conveyor tube indicated that no coils were operating above safe insulation temperatures.

Jamming caused considerable concern during development stages. If balls were being carried through a vertical

run and the power were shut off momentarily, the balls would drop, thus filling up the tube above a corner section. It was then difficult to predict whether or not the conveyor would unjam itself. Calculations were at best only approximate because the balls do not always assemble themselves in exactly the same manner, giving variable reluctance patterns. However, inasmuch as the calculations indicated that a much larger pulling force would be present than that which is actually required to attract and carry the balls, it was believed that unjamming could be accomplished successfully. Tests proved this situation to be true. In fact, the balls always entered the bottom run of the tube faster than it was possible for them to be carried away. Consequently, the entrance of the conveyor always operated from a jammed ball condition, apparently with no difficulty.

On the basis of satisfactory performance during the extensive tests made on the electromagnetic ball conveyor, it is now known that such an apparatus can be used successfully for the transportation of magnetic steel balls.

TELEVISION

A Military Intelligence and Communications Medium

NORMAN GRAY J. C. JANGARATHIS

The continuing need for a more efficient intelligence system in the U. S. Army is focusing attention on television as a basic means of communication. This article summarizes some of the proposed applications for military television in combat, describes types of current interim mobile television units, and presents recent maneuver utilization of two units.

AS LONG AS ARMIES HAVE EXISTED, the problem of acquiring a rapid and accurate intelligence and communications system has been of prime concern to commanders. It has been proved time after time that, in order to win battles, the commander must insure the full working of those communications available to him by protecting primary means and utilizing alternate means as required. Observance of this requirement dictates the necessity for constant vigilance in the development and utilization of new means of communication, such as is offered by television.

REQUIREMENTS OF MILITARY TELEVISION

ONE OF THE MAIN DIFFERENCES between military and commercial television is the military requirement for a higher quality resultant for intelligence interpretation, even though the system may be operating under extremely adverse conditions. Military television as an immediate audio-visual means of communication between all echelons of command appears to be highly desirable, however several limiting requirements exist.

The requirement of high equipment mobility and ruggedness for all tactical units in the modern army applies equally to television development. This requirement brings in the following dependence variables:

Weight and Size. Minimum required to facilitate high portability. Complete television camera chains and transmitters should be carried easily by jeeps in the same manner as are army radios.

Durability. Highest possible to enable television system to sustain treatment that is equivalent to that which other tactical military communications can endure.

Power Consumption. Minimum required to facilitate high portability. High power requirements demand large power generators.

Weather- and Fungusproofing. To insure efficient operation under any climatic condition.

Two other considerations, namely, protection against jamming and methods of propagation must likewise be considered by the military. Methods of propagation have two extremes, the microwave type consisting of a very narrow beam, and a uniform distribution type having a 360-degree radiation pattern. Microwave propagation has a line-of-sight prerequisite that, with present equipment and facilities, is often impossible to obtain under fast-moving tactical field conditions. When this prerequisite is obtained, however, distances of 25 miles may be realized. The strict line-of-sight requirements make cover and concealment difficult, because the reflecting parabolic dishes of the microwave systems must be above the sur-

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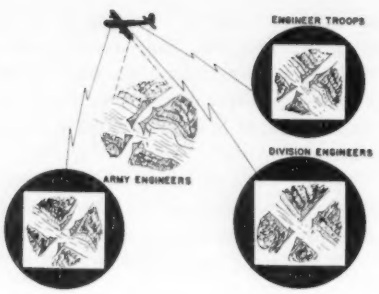


Fig. 1. Engineer reconnaissance and television.

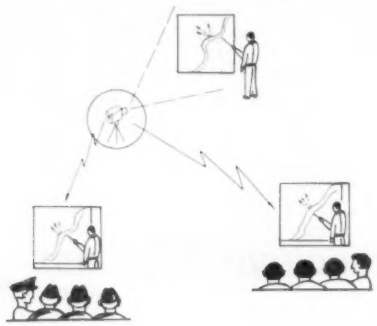


Fig. 2. Command conference — sound and sight briefing.

rounding vegetation. To obtain line-of-sight often requires towers of considerable size. Tower construction at the present time is time consuming and lends itself to a semi-fixed type of installation. New hydraulic telescoping towers may solve this mobility problem very soon. Since microwave is highly directional, having a beam width of approximately 2.5 degrees, and being transmitted in most tactical applications from forward areas toward rear echelons, the ability of the enemy to intercept these signals, while possible, is limited.

Semidirectional and uniform radiation patterns, moving toward the other end of the methods-of-propagation scale, do not require strict line-of-sight and can penetrate wooded terrain. The operating range of ground-to-ground transmission is, however, very limited, being about 5 to 7 miles with present equipment. Telescoping antennae and high-power output transmitters are being investigated for increased range. One outstanding advantage of this method of propagation is the capability of transmitting on the move. This method is the one utilized by airborne television pickup stations. A serious disadvantage is the fact that the enemy can intercept the signal without great effort on his part. Coded signals and preplanned orientation of pictorial information may combine to decrease this possible intelligence leak considerably.

BACKGROUND OF ARMY TELEVISION

In 1948, the U. S. Signal Corps contracted for the construction of the first U. S. Army mobile television system. The unit was designed for the purpose of exploring military applications of television, and included the necessary auxiliary equipment to provide for self-sustained field operations. From this initial unit and its utilization by the Army Pictorial Center in Long Island City, N. Y., new applications and more efficient systems were suggested and investigated. The growth of television at the Army Pictorial Center has illustrated the requirements for varying types of military television systems.

The value of the use of television in tactical situations was immediately apparent and tactical applications were investigated at several posts. The tactical situations in which the original unit could be used were highly restricted because of the great size and weight of the unit. Inasmuch as the few restricted ventures into tactical employment of television were highly promising, it became obvious that a second unit was needed, constructed around small light miniaturized equipment, so that further experimentation in this field could be carried out. Consequently, in December 1952, steps were taken to obtain the first tactical-type unit. The mission of this unit was to study and evaluate the employment of television in tactical situations. Information acquired from the activities of this unit has broadened the proposed applications of military television and has been used in the planning of the more recent military television systems.

A requirement for high-quality kinescope recordings for training purposes and troop information also became apparent. The low-cost kinescope method of producing training and information films brought about the establishment of Studio F at the Army Pictorial Center in 1952. This well-equipped television studio provides the facilities for recording on 35-mm black-and-white film; with quality productions closely approximating that of standard film being attained.

The television activities of the Army Pictorial Center include: television field units being used in the investigation of television in military applications; a unit that plans, organizes, engineers, co-ordinates, and conducts studies in the application of television to military uses; and a unit

Fig. 3 (left). Combat television unit, truck mounted.

Fig. 4 (right). Combat television unit.

that operates the television facilities used in the making of television kinescope recordings, both in the Army Pictorial Center studios and in the field. The organization, the equipment, and the personnel of the television units at the Army Pictorial Center are geared to the goal of acquiring information concerning military television and its utilizations, as well as insuring that the Army keeps ahead in the field of television progress.

MILITARY APPLICATIONS

TELEVISION APPLICATIONS to military uses may be divided into two general categories, combat and noncombat. The combat use of television will require considerable developmental work, whereas the noncombat type in many applications will utilize modified existing commercial equipment. Inasmuch as the field of military television is too broad to be covered adequately in a single article of this type, attention will be focused on combat television in reference to its utilization as an intelligence and communications media.

Reconnaissance and Surveillance. It is axiomatic that a commander requires an accurate and timely estimate of the tactical situation to help him make the proper decision during combat. Television, properly utilized in tactical applications, can provide immediate visual information of critical areas and activities to the commander and his staff. Television systems mounted in light aircraft, tanks, and light trucks are now being evaluated to determine the technical characteristics and utilization that is possible for each of these operations. Small planes equipped with television cameras and transmitters can fly over areas about to be invaded, in order to furnish required information such as last minute engineer reconnaissance of a critically located bridge, as shown in Fig. 1. Television equipment mounted in jeeps and tanks can be attached to front-line spearheading elements. This type of television pickup station could transmit visual information of bridges, road blocks, general terrain features, captured equipment, etc., relaying to the commander an accurate pictorial description of selected portions of the front-line situation. Television equipment mounted in pilotless tanks may avoid traps into which our forces may fall, while enabling the armored force commander to utilize the remotely controlled tanks as forward scouts, giving him immediate information. Immediate accurate data as to the results of bombing attacks or artillery preparations can be furnished, which will help ensure the most efficient use of our striking forces.

Fire Control. The control of artillery fire calls for accurate and continuous outpost information. During World War II, *L-4* and *L-5* observation planes frequently performed this mission, at times flying almost directly over the target area. This same fire-control information can be obtained by pilotless planes (drones) equipped with television equipment. Decisions with greater speed and accuracy can be made by army, corps, or division artillery commanders if they see for themselves an immediate action picture of the target area during the attack.

Data Transmission. Message traffic, weather information, requisitions, and all other types of military communications must be relayed promptly and efficiently before and during combat actions.

A slow scan vidicon television system is available and is being further improved, whereby duplicate copies of messages, photographs, and all types of data information can be transmitted to a distant receiving site. The transmitting end of this system consists of a slow scan vidicon camera, with the control equipment having a technical control monitor and a transmitter. Although the bandwidth of the signal derived from the slow scan camera chain is relatively narrow (3 to 6 kc), the means of propagation can vary from microwave to existing radio and telephone conductors. The electrical impulses received at the receiving end are converted to visual information on a specially designed picture tube having phosphors of high persistence. A 16-mm camera chain focused on the picture tube provides a negative or positive print. From this, any number of enlarged positive prints may be made

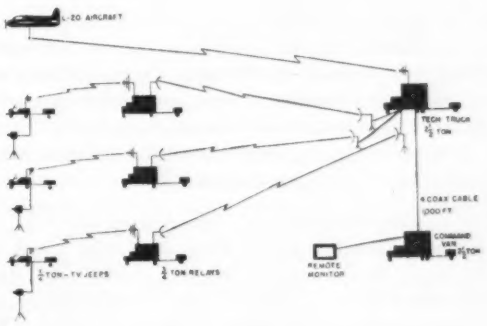


Fig. 5. Combat television system layout.

or the film may be projected on a screen for rapid inspection.

The forward element transmitting equipment can be mounted in a jeep or comparable size vehicle for mobility.

The slow scan vidicon pickup and kinescope receiving system is capable of more immediate transmission of greater quantities of written or photographic information than presently available with conventional facsimile or teletype equipment.

Command Conference. Face-to-face conversations between commanders and subordinates in combat are often difficult because of time considerations. When face-to-face briefings are not feasible, current practice indicates the utilization of teletype or telephone conferences. Conferences accomplished through the medium of television will permit instantaneous transmission of verbal or written instruction, information of new or captured equipment, interrogation of prisoners of war, and exhibits of maps, diagrams, or charts. With a properly set up television system, each commander can remain at his command post while participating in a sound and sight briefing, as shown in Fig. 2.

Fig. 6. Jeep-mounted television pickup and transmitting station. ◀

Fig. 7. Light aircraft-mounted television pickup and transmitting station. ▶

The applications discussed in the foregoing are only a small part of the military television potential. As experimentation and experience is increasing, the field is broadening; thus, it is foreseen that television will become a basic means of communication, along with the written hand-carried message, wire, and radio.

EXAMPLES OF MILITARY TELEVISION USES

THE POTENTIAL of television as an intelligence media is almost unlimited. To illustrate some current activities in this field, two of the Army Pictorial Center military television units and a portion of their activities during recent maneuvers will be described. To supplement this, integration of the recently acquired man-pack television system with current systems will be included.

River Crossing Demonstration. On August 11, 1954, the Army Signal Corps Interim Tactical Television Units, and the National Broadcasting Company (NBC) and Radio Corporation of America (RCA) Color Television Caravans gave a combined military television demonstration at Fort George G. Meade, Md. The purpose was to demonstrate some of the potential applications and capabilities of a tactical television communications system. The demonstration was designed around a regimental attack involving a river crossing, armored action, artillery support, and air evacuation and was planned to provide as many applications as possible for military television coverage. This maneuver was covered by a more extensive tactical television operation than had ever previously been performed and gave the best opportunity, up to that time, for evaluation of television equipment and operating techniques under tactical conditions.

The three microwave signals from each of the ground cameras and an airborne signal were all received at a $2^1/_2$-ton truck located at the command post. Each picture was displayed on a monitor in the truck for use in controlling the technical operation of the entire system. Each picture was also sent to a monitor at the command-post for viewing by the military and civilian audience.

Disregarding field characteristics of specific equipment used, certain fundamental requirements for tactical employment of television in the Fort Meade maneuver were lacking. The immobility of the microwave systems, the elaborate and specific preplanning for television coverage, and the staged performance of the maneuver were fully realized; however, the value of the experience obtained, and the lessons learned, were inestimable. Ranking officers at the command post saw, for the first time, the enormous possibilities for obtaining intelligence by military television covering a tactical action. The design of the most recently acquired military systems was expedited and enhanced through experience gained during this maneuver.

Ground Combat: In July 1955, the Army Pictorial Center received a newly designed unit: a compact mobile television system designed to provide television communication in field situations and under field conditions. The design of this unit was a direct outgrowth of the experience derived from exercises similar to the river crossing briefly covered in preceding paragraphs.

Maximum utilization of the unit (Figs. 3 and 4) provides a television picture from each of four different locations (Fig. 5). Three of the pictures are from mobile ground locations; the fourth is a picture from a television camera that is mounted in a light aircraft. The pictorial information from these four sources can be transmitted a maximum of 25 miles to a command viewing site. The unit also can record photographically still pictures of a television image.

Technical Operation. Each of the three jeeps carries an industrial-type television camera, as shown in Fig. 6. This camera measures $4 \times 6 \times 8$ inches in size and can easily be hand carried. Camera cable carried with each jeep will allow the cameraman to operate as far as 250 feet from his jeep. The small camera may also be mounted and operated from the jeep. A small television transmitter is associated with each camera. The picture signal from the camera is fed into this transmitter and is broadcast a maximum of 1 to 5 miles (depending on terrain) to the relay truck assigned to that jeep.

At the relay truck, a receiver picks up the picture broadcast from the camera jeep and feeds the video signal into a microwave transmitter mounted on top of the truck. This microwave transmitter is beamed to a receiving antenna located near a technical van at the receiver site. Maximum distance between the relay van and the technical van varies, depending upon terrain features, up to 20 miles. This distance must be measured on a line-of-sight. The technical van receives microwave signals from all three relay vans.

The light aircraft, Beaver *L-20*, carries two airborne

image orthicon television cameras. One is mounted in the "belly" of the aircraft. The other has a flexible mounting and is controlled by the cameraman (Fig. 7), who can move it within the limits of a port in the side of the aircraft. A signal, from either one of these cameras, is fed into a transmitter mounted in the aircraft. The airborne transmitter can broadcast the signal 10 to 25 miles to a receiver in the technical van. The technical van maintains technical control of the system and supplies video information from the four picture sources to the command van. The television unit commander can control the entire operation from the command van. He has radio contact with all vehicles, cameraman, and the aircraft and is able to remote-control the selection of the desired pictures to be broadcast over the system at any given time. The command van is located as close as terrain features permit to the command post of the tactical commanding officer utilizing the television system. The command van is utilized for final viewing of the televised pictures. A specially designed still camera is available in the command van for recording pertinent visual information directly from the face of the receiver.

Exercise "Sagebrush." The television unit described above went through its first complete field test at "Exercise Sagebrush." This maneuver was of the "free" type, having two relatively equal opponents. The television unit was attached to a division reconnaissance troop and its mission was to provide instantaneous visual coverage of the tactical situation for the commander and his staff. The unit was used to provide coverage of various tactical situations, both air-to-ground and ground-to-ground, including: (1) verification of nonvisual information by means of supporting pictorial information; (2) location of friendly and aggressor units and emplacements, and to study enemy activities; (3) study of terrain features; and (4) transmission of pictures of captured enemy material.

To illustrate the manner in which television was utilized during "Exercise Sagebrush," the following excerpts from television missions are cited:

"17 Nov 55. The mission of running TV airborne road reconnaissance of the aggressor Army's main route of advance was assigned to the TV Section. Video was transmitted from the airborne pickup station to the command post receiving site. Video reception was acceptable and supplied information concerning road blocks, amount and type of traffic tie-ups, and general traffic conditions.

"19 Nov 55. Three TV jeeps were dispatched to key points along the main route of advance. Their primary mission was to televise pertinent information to the tactical commander. Vehicle and troop movements were televised, and particular attention was given to traffic bottlenecks and equipment failures or fatalities (umpire scoring). This operation illustrated that the maximum transmitting range of the video signal from the jeep over heavily wooded terrain was 1.5 and 2.0 miles.

"In conjunction with these activities, an air mission was very successful. This mission was to provide TV coverage along the main line of resistance. Airborne coverage enabled Division Advanced Headquarters to watch the operation of a mass movement of large vehicles behind a small screen. The co-ordinates of this movement were requested and obtained from the camera operator. In this operation, the Division *G-2* (Intelligence Officer) had TV coverage of an area 20 miles forward of his position."

Fig. 8. Man-pack television.

In general, the newest interim tactical unit accomplished its over-all maneuver mission. The maneuver activities provided valuable information pertaining to utilization, special considerations, and definite limitations of presently available field television equipment.

Television was used as an integral part of a combat unit. Actual conditions of war were simulated and no "staged" type of demonstrations were included. This maneuver helped illustrate that television can be used for tactical employment.

Special considerations such as line-of-sight prerequisite for microwave propagation, maximum altitudes for airborne coverage, and cable limitations between jeeps and cameramen were still evident. Limitations were present, but the comparison between older television systems and the new unit was encouraging.

Existing problems were realized; some have been solved and new developments continue. The following list of recommended improvements are presented to illustrate some of the problems which confronted this television unit:

1. A more stable synchronization should be built into camera chains. Experienced personnel and commercial engineers have found that, under field conditions characterized by very high humidity, adjustments of count-down synchronization controls require constant adjustment. Count-downs and blanking controls should be adjustable from the outside since normal working adjustments require removal of side panels, which is dangerous to personnel and equipment in inclement weather.

2. A mixer should be added to the camera chains, with adjustment for synchronization and blanking levels, which would permit a composite video output signal, enabling direct cabling into relay vans. This would increase tactical capabilities during jamming by eliminating the broadcast feature of the system.

3. Present uhf Yagi antenna is too fragile; a method for rapid rotation of the antenna and a system to vary its height is needed.

4. A 110-volt a-c operated crystal-controlled average 100-watt 360-mc output transmitter is needed for increased jeep operating range.

5. Utilization of a helicopter aircraft for reconnoitering microwave sites and transporting microwave relay equipment to locations not accessible to wheeled vehicles should be considered.

6. A monitoring device for the pilot of the *L-20* aircraft would increase efficiency of aerial coverage. A picture monitoring device available to the pilot would allow the pilot to see what his cameraman is shooting and make it possible for him to follow directions from cameraman more quickly and efficiently.

Man-Pack Television. Most recent of the Army's television equipments is the man-pack television unit: a light compact combination of television chain, power unit, and transmitter, as shown in Fig. 8. The camera weighs only 8 pounds and the transmitter with built-in power supply, 47 pounds. Four interchangeable lenses, including wide angle to view a broad sector and telephoto for great distances, are available for diversified tactical employment. The transmitter has a half-mile to a mile range, and can operate continually for 2 hours off its five cell rechargeable battery. The receiver portion of the man-pack television unit may be jeep-mounted for mobility. This receiver has a 10-inch picture screen.

To minimize possible interception of the television signal, the camera can also be used with a cable between the transmitter and receiver. With power packaged within the transmitter, cable size is four times smaller than in earlier models. The greatest asset, however, of this unit is the capability it gives the cameraman to move over almost any type of terrain without being limited by accompanying cables.

CONCLUSION

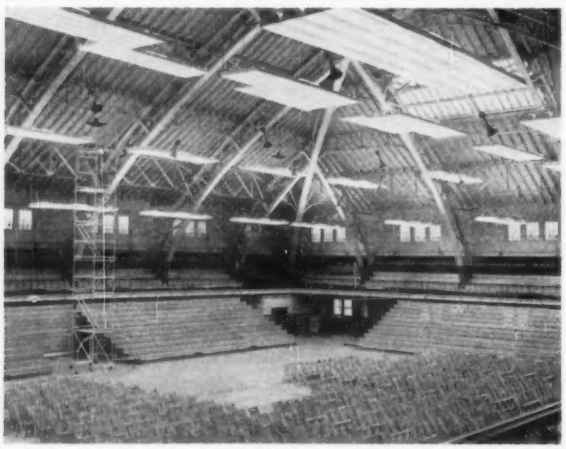
ARMY TACTICAL TELEVISION is rapidly growing from the cumbersome studio-type equipments of just a few years ago to the man-pack television pickup and transmitting stations of today. The participation of television units in varied type military applications is increasing steadily, thus providing much needed operational experience.

Since its infancy in 1948, Army television has illustrated an over-all potential that is, at least, equal to other major intelligence and communications media. The ability to provide immediate visual information of critical areas many miles forward of the receiving site, gives the commander "eyes" throughout his command in forward areas and in enemy installations. Application research, equipment improvement and development, and advanced training of military operating personnel is continuing in an endeavor to determine the ultimate military potential of television.

Television is being used as a reconnaissance and intelligence tool, a sound and sight briefing aid, and an intelligence data transmitter. The results are gratifying and create enthusiasm. It is envisioned that military television will eventually become a basic means of electronic communications and take its place beside the telephone and radio.

Camden Convention Hall Lighted by High-Frequency System

A new, high-frequency fluorescent lighting system providing twice the nighttime illumination of the average big league ball park illuminates the modernized Convention Hall at Camden, N. J. The 400-cycle system represents a highly improved method of obtaining higher levels of light in high-ceilinged buildings. Conceived by William T. Harker & Associates, Camden consulting engineers, the lighting system was designed and developed with the aid of General Electric Company specialists. The installation was handled by Gerald Electric Construction Co., Inc., Woodbury Heights, N. J.



With highly simplified control and maintenance features, the new system illuminates 40,000 square feet of floor area to a maintained level of 70 foot-candles. Although of high intensity, the new system spreads a soft, diffused lighting over the entire floor area of Convention Hall, plus a spillover illumination for the balcony section. Economically, the new lighting system costs less per foot-candle to install and maintain than the incandescent system originally installed in the building. It offers up to an estimated 15 per-cent savings in annual operation and maintenance cost, while producing 50 per-cent higher levels of comfortable light than previously available.

The entire lighting system can be controlled from the balcony or from a downstairs station. The operator can vary the lighting intensity to spot parts of performances and adjust to the particular lighting requirements of the various events to be held in Convention Hall.

Although somewhat similar lighting systems have been developed by General Electric for other installations, the Convention Hall lighting job is the first incandescent system to be modernized by the high-frequency lighting technique. Operating on a motor-generator set supplying 400-cycle power, the system is the fourth high-frequency lighting system now in operation.

Power Company Microwave Communications System

G. D. PERRY, JR.
ASSOCIATE MEMBER

EUGENE LANGONE
ASSOCIATE MEMBER

SOUTHERN COLORADO POWER COMPANY'S transmission system consists of 115-kv lines between its plants at Canon City, Pueblo, Rocky Ford (via La Junta substation), and the Colorado Springs municipal system. These lines all terminate at West Substation located 5 miles northwest of Pueblo. Efficient system operation requires communication with all plants and control of West and La Junta substations by the Pueblo dispatcher. Microwave communication was selected for the Pueblo-West station link. Carrier relaying with communication is used on the rest of the lines.

The equipment at Pueblo and West Substation is General Electric Company's type *UA-1-D* 2,000-mc time division multiplex. Supplied as a 12-channel repeater connected as a terminal, each station requires the addition of r-f units only for conversion to a repeater. Expansion to the full 25-channel capacity requires additional channelizing equipment. System expansion is important because future plans include remote operation of the company's two-way radio system and supervisory control via microwave of a future station.

The operational communications systems for the Southern Colorado Power Company is shown in Fig. 1. The three voice channels provide two-wire 20-cycle ring down service between Pueblo and the generating plants at Canon City, Rocky Ford, and Colorado Springs. Full party-line service is available at West Station, where these channels terminate in carrier equipment.

Two channels are used to relay the 115- and 69-kv lines between Pueblo and West Station. Two channels are used for supervisory control of West and LaJunta Stations. The LaJunta substation is controlled from Pueblo via microwave to West Station and then to LaJunta via 115-kv line carrier.

The microwave carrier frequency is generated by a crystal-controlled 90-mc oscillator, followed by a frequency tripler and a septupler. The transmitter video section consists of pulse amplifiers, clippers, and a pulse reshaper circuit. The clipping and pulse reshaping result in significant signal-to-noise improvement on multipath systems.

The unmodulated r-f carrier generated in the transmitter is used as the receiver local oscillator. A receiver sensitivity of −108 db at multiplex threshold is obtained using preselection prior to the *1N21C* crystal mixer, line above ground head-end, and an i-f cascade input stage. Automatic gain control provides constant receiver output over a 50-db input-signal variation. A duplexing system permits transmission and reception over one antenna system.

Time-division multiplex may be defined as combining multiple circuits by assigning each circuit or channel a portion of a recurring time cycle. The multiplex signal consists of a series of pulses, each having a definite time relationship to a group of synchronizing pulses which represent zero time. The input signal to a channel is sampled several thousand times a second. The magnitude of the input signal at the instant of sampling determines the position of the channel pulse with respect to zero time.

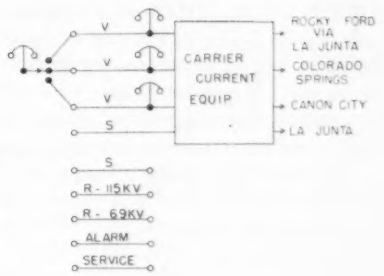


Fig. 1. Microwave channels.

V—Voice; S—Supervisory control; R—Directional comparison relaying.

Realization of the advantages of time-division multiplex depends upon the method of synchronizing the channel pulses with respect to the sync pulses. Four quadrature sine waves form the heart of General Electric's 25-channel quadriphase system.

The multiplex consists of five basic units. The transmitter sync generator generates the master timing group of pulses. This sync pulse group consists of three 1/2-microsecond pulses spaced 1/2 microsecond apart. The unit also generates the quadrature voltages used to synchronize the channel pulses.

The receiving sync generator contains the circuitry for synchronizing a slaved oscillator to the repetition rate of the received multiplex signal. The quadrature voltages generated in this unit have the same relationship to the sync pulses as those in the transmitter sync generator and are used to generate the gate pulse required to demodulate the desired channel.

The channel unit contains the circuitry required for modulation and demodulation of a channel pulse. Channel selection by use of precision resistors connected across adjacent quadrature voltages enables use of identical channel units.

Standard channel termination units provide all necessary equipment for ring down or dial service, remote very high frequency base station control, telemetering, and supervisory control.

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Digest of paper **56-60,** "A Microwave Communications System for the Southern Colorado Power Company," recommended by the AIEE Committee on Carrier Current and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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Motor for Atomic Reactor Rod Mechanism Drive

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THE OPERATION of heterogeneous atomic reactors depends upon a number of control rods, which are lifted in and out of the reactor so as to control the flow of neutrons. At present, these rods are driven by slow-speed reluctance motors operating at speeds between 5 and 15 rpm, producing torques between 3 and 25 foot-pounds.

The reluctance motor consists of a wound stator very similar to the stator of a 3-phase induction motor. The power supply of this stator is d-c modulated to give a frequency of the order of 1 cps.

The rotor is entirely submerged in the primary fluid (irradiated water) at a pressure of 2,000 pounds per square inch (psi). The stator winding is protected from the water by a thin can of Inconel welded to the stator teeth. The rotor itself consists of a solid piece of martensitic stainless steel, having reasonably good magnetic properties.

In this type of motor, the reactance is negligible and, therefore, the calculation of performance resolves itself into the prediction of a torque–ampere curve. This article describes a method of torque calculation and the work is carried through on an actual example.

The principle applied in this calculation is a graphical interpretation of Maxwell's law of electromagnetic induction. This interpretation states that in an electromagnetic system capable of deformation, if $O\phi_1$ is the saturation curve corresponding to a given air gap and $O\phi_2$ is the saturation curve corresponding to a second air gap, the area included between the two curves is a measure of the mechanical work of the moving part (Fig. 1).

In calculating the torque of such a machine, the procedure is as follows: (1) establish the relationship between peak current and peak ampere-turns; (2) assume the ampere-turn wave is stationary in space and determine the saturation curve for one position of the rotor; (3) allow the rotor a small displacement and determine the new saturation curve for the second position of the rotor; (4) measure the area between the two curves and convert the result into work units and, therefore, into torque units; and (5) determine the saturation curve at 45-degree electrical shift position and at one close to it (for instance, 36 degrees). For both the 0-degree shift position (center of rotor pole in line with peak of ampere-turn wave) and 90-degree shift position (center of rotor pole in line with zero of ampere-turn wave), the torque is zero. The torque is maximum at the 45-degree position. The balance of the calculation is concerned with the mechanics of obtaining the saturation curve and the final calculation of torque.

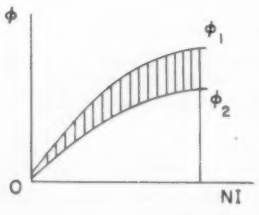

Fig. 1. Saturation curves

An outline of the steps follows: Assuming that the mmf drop across gap and teeth is sinusoidal in space, determine the field form for several values of peak ampere-turns, as follows: (1) Divide the 90-degree sector into equal subdivisions and draw probable flux lines in the air gap. (2) Calculate the effective length of the air gap by using Carter's coefficient. (3) Determine the curve of ampere-turns in the teeth versus air-gap flux density, taking into consideration the ratio of air to iron. (4) Determine for each air-gap line of flux the straight line representing ampere-turns in the air gap versus flux density in the air gap. (5) Determine the value of the flux density in the air gap along the entire periphery of the rotor from 0 to 90 degrees (for several values of peak ampere-turns in the gap and teeth); this is obtained from the plots of (3) and (4). (6) For each chosen value of peak ampere-turns in the gap and teeth, a flux plot is thus obtained; the ratio of the average value of this plot to the maximum value is the form factor C_p, and this form factor multiplied by the area of the gap gives the actual flux; for each chosen value of the peak ampere-turns gap and teeth, a value of flux is obtained; plot this flux against the ampere-turns; (7) calculate the saturation curve of the balance of the magnetic circuit; however, since the distribution of ampere-turns in the gap and teeth has been assumed to be sinusoidal, the same assumption must be made for the balance of the circuit and the ampere-turns considered will be the calculated ampere turns multiplied by $\pi/2$; (8) estimate the leakage flux and add it to the flux in the stator yoke; and (9) as two saturation curves have been determined, one for the gap and teeth, the other for the rotor core, the rotor pole, and the stator yoke, combine these two curves into one curve (adding ampere-turns for given values of flux); the result is the saturation curve for the position of shift considered.

Repeat this procedure for a second position of shift, not too far removed from the first position. If it is desired to have a complete variation of torque versus position of shift, this procedure can be repeated as many times as necessary.

For any value of peak ampere-turns considered, the area between two adjacent saturation curves will be the measure of work. The area in question is measured in ampere-turn Maxwell units. If S is the measure of this area, the torque T in foot-pounds is $T=3.68SDp/\Delta e10^{-9}$ where p is the number of poles, D is the motor diameter in inches, and Δe is the displacement in inches at the rotor periphery. Several calculations of reluctance motors were made using this method and they yield reasonable results.

Digest of paper 56-725, "The Design of a Very Slow Speed Reluctance Motor for Atomic Reactor Rod Mechanism Drive," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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Rating and Application of Semiconductor Rectifiers

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DESPITE the high efficiency of germanium and silicon p-n junctions, the small internal losses of this type of rectifier cell are the chief criteria for rating and application.

The junction generates heat during the course of operation by virtue of two losses: voltage drop across the rectifier while it is conducting in the forward or easy-current-flow direction; and leakage current through the cell when it is restraining the flow of load current in the reverse or blocking direction. Using the voltage-current characteristics of the specific rectifier cell being considered, satisfactory solutions for heat generated at the junction can be obtained by graphically integrating the instantaneous product of forward current and forward voltage drop, and the product of reverse current and reverse voltage, for the voltage and current wave shapes imposed by the particular application. The sum of average forward heating and average reverse heating yields average heating of the junction over the complete cycle.

The p-n junction usually is soldered to a copper stud which, in turn, is mounted on a radiator or cooling fin. This mechanism affords a highly conductive path to the cooling fin for the heat generated at the junction. The fin liberates this heat to the surrounding medium by radiation, convection, and conduction. The continuous-duty temperature rise of the junction above the ambient can be expressed as the product of the average heat flow and the thermal impedance between junction and ambient.

If this thermal impedance, together with voltage-current characteristics and recommended junction operating temperatures, is available for a device, the equipment designer has the basic information for determining the continuous-duty operating temperature of the rectifier junction under any condition. Conversely, he has the data necessary to determine how many cells, and in what configuration he must arrange them, to achieve his load voltage and current requirements. For commonly encountered voltage and current wave shapes, the device manufacturer usually publishes forward-current ratings determined in the foregoing manner for various ambient conditions.

In well-fabricated germanium-rectifier cells, reverse heating for a fixed reverse voltage varies approximately exponentially with junction temperature in the normal operating range, as indicated by curve P_{rj} in Fig. 1. The heat generated by a specified forward current is relatively independent of junction temperature, dropping only slightly as the temperature is raised. This variation P_f is also plotted in Fig. 1, and is added to the reverse heating to yield total junction heating P_t. The origin of the abscissa is the ambient temperature of the application. From this point can be laid out the heat-dissipating characteristic of the rectifier, essentially a linear variation.

When the rectifier cell is energized in the circuit, the junction will heat as defined by the heat-generation curve, and will cool as defined by the heat-dissipation curve. The junction temperature will rise to the point where heat generation exactly matches heat dissipation. This occurs where the two curves intersect. The area enclosed by the two curves is a rough measure of the inherent stability of the application.

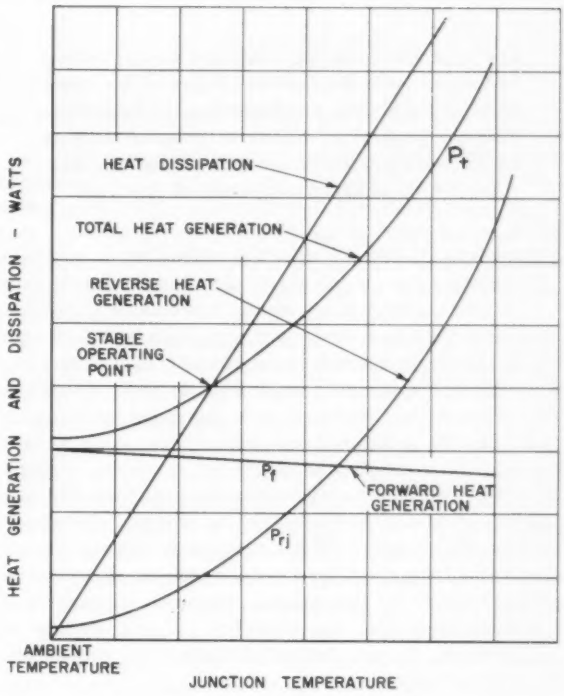

Fig. 1. Thermal characteristics of a rectifier cell under constant load and voltage conditions.

If junction heating is increased by additional voltage or current, or by raising ambient temperature, or if cooling is reduced, the overlap of the two curves decreases, and, if taken to extremes, the two curves fail to intersect. Under these conditions, the rectifier cannot stabilize thermally. The temperature of the cell increases to the melting point of the junction or to the point where thermal stress causes cell failure. This action is referred to as "thermal runaway." Because of their inherently higher reverse heating, thermal stability criteria are usually of more importance for germanium rectifiers than for silicon devices.

Digest of paper 56-934 "Rating and Application of Germanium and Silicon Rectifiers," recommended by the AIEE Committee on Metallic Rectifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Communication and Electronics*, 1956.

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Principles of Programming

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A hypothetical sample computer having a limited order code is described, followed by some examples of simple programming. These illustrate the general principles of programming as well as some aspects of the type of thinking necessary for utilizing computers of this kind.

THE PROCESS OF PROGRAMMING or coding a problem for an automatic digital computer is akin to the problem of translating instructions as to what is to be done into another language, namely, a language which can be interpreted by the circuitry of the machine. The language of the machine, or its order code, is a collection of commands expressed in a numerical code, which cause certain arithmetic and logical operations to take place. The vocabulary of computers, consisting of some 50 to 100 "words," is very limited in comparison with the number of words understood by an average sixth-grade student, for example. This limitation is somewhat compensated by the great speed with which the computer is able to execute the instructions. However, the process of communicating with the machine, i.e., the process of programming, is very distinctly influenced by this vocabulary limitation.

A program for a certain computational problem is a serial list of commands which spell out in minute detail the step-by-step computations and operation, which are to be performed. Preliminary organization of the problem is dictated largely by the order code which the available computer is able to interpret. Computer logic and order codes vary widely from one machine to another. It is not necessary to understand in detail the construction and operation of a computer in order to formulate a program, but it is essential to intelligent application of a given computer to understand certain elementary features of its organization and mode of operation.

With many types of computers in existence, it is very difficult to generalize programming principles and techniques without referring to a specific machine through illustrative examples. Furthermore, many existing computers are too involved and complex to serve as a vehicle for a brief introductory discussion of the matter. For these reasons, the subsequent discussion of programming in this article will be based on a hypothetical sample computer having a very limited order code. First, the computer and its order code will be described, and then some simple programs will be illustrated utilizing this order code. The discussion is limited to the stored-program type of computer, that is, one in which instructions and data are stored together in a common memory device. One of the fundamental features of such computers which makes them so versatile and useful is the fact that arithmetic operations can be performed on the code instructions by the computer itself, and in this way the computer alters its instructions during the course of computation.

Essentially full text of conference paper CP56-967 presented at the AIEE Fall General Meeting, Chicago, Ill., October 1–5, 1956.

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ORDER CODE AND OPERATION OF A SAMPLE COMPUTER

Computer Organization. Fig. 1 shows in block diagram form the principal components of a stored-program type computer. Features of a hypothetical sample computer to be used in subsequent discussion of programming will be described. Input and output may be tape, punched cards, or electric typewriter. Details of input and output will not be of importance in the present presentation.

Storage or memory units take many forms, but for the purpose of illustration, memory can be visualized as a tabulation of 1,000 entries or cells, in which it is possible to store that many numbers. Action of the control unit can extract any of these entries and transfer the number to the arithmetic unit. This removal of information from memory does not erase the number stored there. When a number is transferred to a memory cell by the action of the control unit, the new entry obliterates any information previously stored in that cell. The location of each of the 1,000 cells in memory is identified by an "address" in the form of a 3-digit number. The addresses range from 000 to 999, inclusive.

The arithmetic unit is capable of adding, subtracting, multiplying, and dividing. Associated with the arithmetic unit is an accumulator, which holds one of the numbers involved in these operations and in which appears the result of each arithmetic operation. The second operand in each arithmetic operation is obtained from memory.

The control unit operation is governed by a sequence of commands which form the program for the computation. These commands are expressed in a numerical code and stored as numbers in the memory, along with numerical data involved in the problem. Operation is initiated by setting the control unit to withdraw from the proper memory cell the first command of the program. Then the control steps through the program automatically by withdrawing additional commands from successive memory cells, proceeding in numerical sequence through addresses following the starting point, until a command is reached calling for the operation to stop or until the program itself transfers control to another sequence of memory addresses.

Word Structure. The term "word" refers either to an item of numerical data or to a command in numerical code. No distinction is made in the computer between a

command and a number. It is only by action of the programmer and the machine operator that words representing commands are directed to the control unit for its interpretation in controlling operation of the machine and processing other words which represent data.

The sample computer will accommodate 8-digit decimal numbers with sign, as indicated by the following form: $\pm .a_1a_2a_3a_4a_5a_6a_7a_8$. In this, each of the letters $a_1 \ldots a_8$ represents any of the decimal digits, 0 to 9. The decimal point is located at the left, that is, the computer recognizes only numbers less than unity in magnitude. If, in the course of computation, some operation produces a number equal to or larger than unity, this causes the accumulator to "overflow" and set an overflow switch (OFS). In this event, on the next command execution the computer will halt unless this next command is one of a special nature which utilizes an overflow to transfer control to a new sequence of commands. This will be explained in greater detail in the section describing the order code.

In an 8-digit number representing a command word, digit positions a_1, a_2, a_3 are spares, digits a_4, a_5 contain a 2-digit code for the operation, and digits a_6, a_7, a_8 contain the memory address of one of the operands. A command word is written in general form as: $\pm .s_1s_2s_3c_1c_2x_1x_2x_3$. This is called a "single address" code in that the command contains only one address. In operations involving two operands, the one operand is obtained from the memory location identified by the 3-digit address part of the command, the other resides in the accumulator, and the operation which takes place is dictated by a 2-digit code occupying position c_1, c_2 in the command word. The set of 2-digit numbers c_1 c_2, which the machine is capable of translating into useful arithmetic or logical operations, is called the "order code" of the machine.

In our sample computer, the sign of a command word is ignored by the control unit in processing this command. Command words can be operated upon in the arithmetic unit as if they were ordinary numbers or data, and in this case the algebraic sign associated with the command word influences the result of such operation. The ability of the machine to alter commands, under direction of the program, of course, is a feature of central importance in the stored-program type of computer.

Order Code. Before illustrating some programming techniques in connection with the sample computer described in the foregoing, it is first necessary to present and explain the order code which is assumed to exist for this machine. Table I contains an order code which, though limited in extent, will suffice to formulate some simple examples of specific programs. One should bear in mind that embodied in the machine, which is capable of interpreting and executing these instructions, is a mathematical ability comparable to that of a sixth-grade student, namely, the operations of arithmetic, a vocabulary vastly more limited than that of the sixth grader, and no intellect whatever.

Table I should be studied carefully, for most of the discussion to follow is based on and employs the operations described there. The following comments are presented to

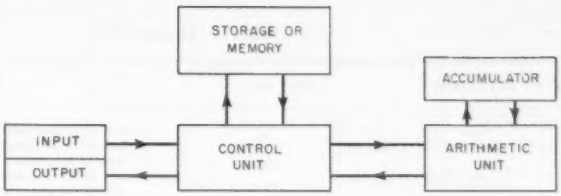

Fig. 1. Computer block diagram.

aid in understanding the information displayed in Table I:

1. The first column gives the numerical code of the operation. This 2-digit code occupies the positions denoted by c_1c_2 in the command word described previously.
2. The second column contains an abbreviation of the operation. These abbreviations will be employed later in writing programs so that it will not be necessary for the reader to memorize the numerical code.
3. The third column contains a statement of the instruction corresponding to the given numerical code, c_1c_2, and the fourth column gives a brief description of what happens in the execution of this instruction.
4. In columns 2, 3, and 4, the symbol x implies the contents of memory cell location $x_1x_2x_3$ listed in the last three digit positions of the command word. In a program, this address is identified by the appropriate 3-digit number. The symbol A in the last column is used as an abbreviation of "the number contained in the accumulator."
5. Note that operations designated as 01, 07, and 12 do not involve numbers in memory, hence the symbol x is omitted. Any digits in positions $x_1x_2x_3$ of command words involving these operations are ignored by the control unit.

To illustrate some of the features of the order code and of notation to be employed later in sample programs, consider the problem of carrying out the calculation: $|I|^2R$, where I is complex, $I=I'+jI''$. To fabricate a sequence of instructions, which will cause the computer to accomplish this, it is necessary to decide where to store in memory the data, I', I'', and R, where to store the program which will process this data, and where to store the result. Arbitrarily, let us assume that the three items of data, I', I'', and R are stored in cells 100, 101, and 102, respectively, and that the storage cells assigned for the program start at address number 200. In writing the program for accomplishing the desired computation, the following form will

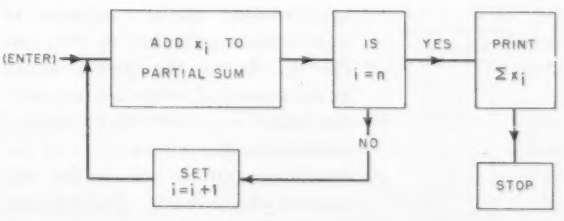

Fig. 2. Flow diagram of summation program.

Table I. Order Code

Code	Abbreviation	Operation	Remarks
01	clear	clear (A)	Contents of accumulator replaced by (+.00000000)
02	add (x)	add (x)	Contents of cell $(x_1x_2x_3)$ added algebraica ly to contents of accumulator
03	subt (x)	subtract (x)	$(A) - (x)$ (i.e. number in $(x_1x_2x_3)$ subtracted from number in accumulator)
04	mult (x)	multiply (x)	$(A) \cdot (x)$ (rounded product is left in accumulator)
05	div (x)	divide (x)	$(A) \div (x)$ (rounded quotient is left in accumulator)
06	store (x)	transfer (A) to memory (x)	(A) is transferred to memory cell $(x_1x_2x_3)$ and upon completion, (A) remains unchanged
07	po	print out (A)	(A) is printed out in the output device
08	tcu (x)	transfer control unconditional (x)	This causes the next command to be taken from address $(x_1x_2x_3)$, and contents of cells following this address are processed as commands in sequence until another transfer control command or a halt command is encountered. (A) not disturbed.
09	tcc(x)	transfer control, conditional (x)	If the preceding operation caused an over-flow (OFS set), control is transferred to the command contained in (x), otherwise control steps to the next address following that containing the tcc command. (A) not disturbed.
10	tcn (x)	transfer control if negative (x)	If (A) is negative, transfer control to (x), otherwise step to next command in sequence.
11	zero (x)	zero check (x)	If $(A) = 0$, step to next command. If $(A) \neq 0$ transfer control to command in cell (x).
12	stop		Machine operation is halted, contents of memory and accumulator are preserved.

need to be used: First, list the assigned memory location of the command word; next, the command operation and address; and, finally, remarks or equations pertaining to some commands as an aid in tracing through the program.

Data

Cell	Contents
100	I'
101	I''
102	R
103	(temporary storage)
104	(final result)

Program

Cell Containing Command Word	Command: Operation	Command: Address	Remarks
200	clear		Clear accumulator
201	add	100	Form I'^2
202	mult	100	
203	store	103	Store partial result
204	clear		Clear
205	add	101	Form I''^2
206	mult	101	
207	add	103	$I'^2 + I''^2$
208	mult	102	Result. I^2R
209	store	104	Store result
210	stop		

The program written in this form can be followed easily, but preparation for insertion into the machine requires an additional step, namely conversion to numerical code. The list at the left of 11 eight-digit numbers is this same program in the form it would take as a sequence of numbers in cells 200 to 210, inclusive. In this, the spare positions in the command words are not used, the fourth and fifth digit positions contain the operation code, and the last three positions contain the address of one operand. The operator would direct the machine to start with the command in cell 200, and then the computer would automatically step through the sequence until the stop order is encountered.

Program:
0.00001000
0.00002100
0.00004100
0.00006103
0.00001000
0.00002101
0.00004101
0.00002103
0.00004102
0.00006104
0.00012000

SAMPLE PROGRAMS

THE SINGLE I^2R COMPUTATION illustrated in the preceding section hardly justifies use of an automatic computer. The main talent of the computer, namely, its ability to execute operations at very high speed, becomes important in very lengthy computations of a repetitive nature. The examples described in this section are selected not to demonstrate the capabilities of an automatic computer, but rather to illustrate some of the features of the process of reducing a computation to a sequence of commands capable of interpretation by the computer. The problems involved in these examples are purposely simple, almost trivial in nature, in order to emphasize the process of programming. For this same reason the matter of scaling, though important in practical applications, is largely ignored. It is assumed that the data involved in the examples are appropriately scaled or restricted in order to avoid overflows which may occur in the course of the computation.

Problem 1. (*Adding a List of Numbers*). First of all, consider the problem of adding a list of numbers and recording the sum. A human computer could be handed the list of numbers and instructed what to do by the single command: "Add this list of numbers." In time, the job would be done. An electronic computer is capable of producing the sum in a small fraction of the time required by the human, but the instructions must be considerably more extensive and detailed.

Perhaps the most obvious program of instructions capable of accomplishing the proposed summation on the sample computer would be to enter the data in memory and then prepare a list of "add" instructions, each one associated with the address of one item of data. The accumulator would first be cleared, and then the desired sum would be formed in it by the successive "add" commands. Finally,

Program 1-a

Cell	Command: Operation	Command: Address
(y)	clear	...
$(y + 1)$	add	(x)
$(y + 2)$	add	$(x + 1)$
$(y + 3)$	add	$(x + 2)$
⋮	⋮	⋮
$(y + n)$	add	$(x + n - 1)$
$(y + n + 1)$	po	...
$(y + n + 2)$	stop	...

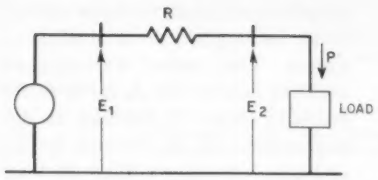

Fig. 3. D-c radial system.

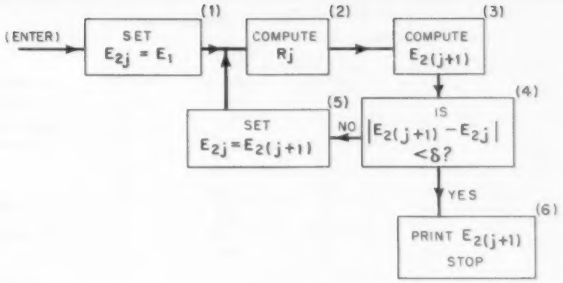

Fig. 4. Flow diagram.

at the completion of adding the last number in the list, the machine would be instructed to "print out" and "stop." The list of instructions would appear as shown in Program 1-a, where x denotes the storage location of the first number in the list of data, y denotes the memory location of the first command in the program, and n is the number of items of data to be added.

Although this program is simple and straightforward, it has several serious limitations: (1) For a list of numbers, the program becomes long and time-consuming to prepare, and also consumes an excessive amount of storage space. (2) The program is limited to processing a data list of a given length n. (3) If the data were stored in a different location in memory, the program would have to be rewritten.

A much more flexible and versatile approach to accomplish this same computation is described in Program 1-b. This program illustrates frequently used techniques of having the program modify its own commands and of a counting operation. The program is written to occupy a specific location in memory, but it will sum a list of numbers located anywhere else in memory and of any length, up to the storage capacity remaining after the program is entered.

In this particular program, the actual numerical computation is contained in the two commands in cells 024 and 008, wherein the next number in the list is added to the partial sum. The reset of the program is concerned with successively modifying the "add" command address with a counting operation to determine when the summation is completed, and with appropriate transfers of information to and from memory. In repetitive computations it often happens that sorting, counting, order modifying, and general "housekeeping" operations require more commands in the program than the actual arithmetic operations.

In Program 1-b, a simple binary decision, i.e., "yes" or "no," is accomplished with the zero-check order at cell 013. Execution of this order answers the question "Is the summation completed?" If the answer is "yes," control proceeds to cells 014, 015, and 016, which cause the answer to print out and halt the computation, otherwise control is directed to cell 018 and the subsequent commands cause the next data entry to be added to the partial sum.

The branching operation, or decision, and the cyclic nature of the computation are indicated by arrows in the left-hand margin of Program 1-b. A cyclic operation of this sort can be indicated in a flow diagram, which is ordinarily constructed before the program is written. A flow diagram representation of the summation process is given in Fig. 2.

In general, the sequence of computations called for in a given flow diagram can be accomplished by a number of different programs, even in the case of a somewhat limited order code, such as that possessed by our sample computer. The programmer usually strives for the program which involves the fewest commands, and this is done for two reasons: (1) to conserve storage space, and (2) to speed up the computation.

To illustrate further the translation of a certain computing job into a program, the summation involved in Fig. 2 and in Program 1-b is also accomplished in the following, Program 1-c. It will be observed that

Program 1-b

Cell	Contents (spare)	(operation)	(address)	Remarks
000	000	00	(n)	Auxiliary words, not used as commands
001	000	00	(x)	
002	000	00	001	
→ 003	000	clear		Places (x) in address part of command in cell 008. After this, cell 001 is temporary storage for partial sum
004	000	add	008	
005	000	add	001	
006	000	store	008	
007	000	clear		
→ 008	000	add	[000	Brackets indicate address is modified by program
009	000	store	001	001 is used for temporary storage of partial sum
010	000	clear		
011	000	add	000	Number of data entries is counted down to zero
012	000	subt	002	
013	000	zero	018	Jump to cell 018 if not zero
→ 014	000	clear		
015	000	add	001	
016	000	po		
017	000	stop		
→ 018	000	store	000	Store count
019	000	clear		
020	000	add	008	Modify address of add command to add next number in the list to the partial sum
021	000	add	002	
022	000	store	008	
023	000	clear		
024	000	add	001	Place partial sum in A
025	000	tcu	008	Return to add command

NOTE: n denotes the length of the list of numbers to added, and x denotes the address of the first number of the list. These two parameters are entered by the operator in cells 000 and 001 before the computation is started and after data storage has been assigned. As the first step in the computation, the control is set to interpret the command in cell 003.

Program 1-c

Cell	Contents (spare)	Contents (operation)	Contents (address)	Remarks
000	001	00	001	Auxiliary word
001	000	00	000	Temporary storage of partial sum
(Start) 002	000	clear		
003	[844]	add	[200]	
004	000	add	001	
005	000	store	001	Partial sum to temporary storage
006	000	clear		
007	000	add	003	Address part of cell 003 increased by one. After 003 is executed 156 times, OFS is set and tcc changes control to po and stop
008	000	add	000	
009	000	tcc	012	
→010	000	store	003	
011	000	tcu	002	
→012	000	clear		
013	000	add	001	
014	000	po		
015	000	stop		

NOTE: The parameters n (length of list) and x (address of first entry) are entered by the operator in the following way: $(1{,}000 - n)$ is placed in the "spare" positions and x is placed in the address positions of cell 003, and in this cell the code for add, i.e., 02, occupies the operation position. Thus, in the present example where $n = 156$, $x = 200$, the word in cell 003 becomes +84402200. Recall that numbers in the spare positions of command words are ignored by control.

this program is somewhat shorter than the previous one, and that the counting operation and order modification are combined. The decision as to when the list is completed is accomplished by purposely producing an overflow and utilizing the conditional transfer of control command (tcc), described in Table I. In order to aid in understanding the program, a specific case is considered, namely, the list to be added contains 156 numbers and is stored in a sequence of memory cells beginning with address 200. The program is stored starting at 000.

Although this program is quite different in appearance than Program 1-b, it accomplishes the same computation called for in the flow diagram, Fig. 2, and does so somewhat more efficiently.

Problem 2. (*Radial line regulation, direct current*). In many engineering problems, computation of the desired result is set up as an iterative process. The present example is intended to illustrate some of the aspects of this type of computation, such as establishing a cyclic operation of the computer which continues automatically until a prescribed precision is reached.

Problems of this type require careful attention to matters of scaling, convergence, means of accelerating convergence, and effect of round-off errors on attainable precision, but these considerations are not elaborated here.

In the radial system of Fig. 3, voltage E_1 at the source is specified, line resistance R is known, load power P is known, and load voltage E_2 is to be determined. An iterative solution is not essential to this problem, but is chosen for purposes of illustration. The d-c system is used for simplicity, although the same method could be applied to a similar a-c system. One method of devising an iterative solution for E_2 involves the following steps: (1) establish an approximation of E_2, denoted by E_{2j} (initially, use $E_{20} = E_1$); (2) from E_{2j} and P, compute load resistance: $R_j = E_{2j}^2/P$; (3) treating the series connection of R and R_j as a potential divider, compute revised approximation: $E_{2(j+1)} = E_1 R_j/(R + R_j)$; and (4) compare $E_{2(j+1)}$ and E_{2j}. If the difference exceeds a prescribed precision index δ, repeat steps (2), (3), and (4), using the revised value, $E_{2(j+1)}$. A flow diagram depicting this process is shown in Fig. 4.

Storage assignment is given, and the program as detailed is given at this point.

Data

Cell	Contents
000	E_1
001	R
002	E_{2j}
003	P
004	R_j
005	δ (a positive constant)
006	Temporary storage

In this program the computation is cyclic or repetitive, but a counting operation is not necessary. The operation continues until the size of successive corrections in voltage E_2 falls below a prescribed value δ. This does not mean

Program 2-a

Block of Flow Diagram	Cell	Contents (operation)	Contents (address)	Remarks
(start)	007	clear		
(1)	008	add	000	
	009	store	002	$E_{2j} = E_1$
	→010	mult	002	E_{2j}^2
(2)	011	div	003	R_j
	012	store	004	store R_j
	013	add	001	$R_j + R$
	014	store	006	store $(R_j + R)$
	015	subt	001	
(3)	016	div	006	
	017	mult	000	$E_{R(j+1)}$
	018	store	006	
(4)	019	subt	002	If $\lvert E_{R(j+1)} - E_{2j} \rvert > \delta$ control is transferred to cell 026
	020	div	005	
	021	tcc	026	
	→022	clear		
(6)	023	add	006	
	024	po		Print so'ution
	025	stop		
	→026	clear		
(5)	027	add	006	Replace E_{2j} by $E_{R(j+1)}$
	028	store	002	
	029	tcu	010	Return

NOTE: Spare positions in command words are not used and will be filled with zeros. The spare positions are omitted in the following tabulation.

Program 2-b

Block of Flow Diagram	Cell	Contents (operation)	Contents (address)	Remarks
		(Command 018 leaves $E_{3(j+1)}$ in the accumulator, see program 2-a. Orders in cells 007 to 018 remain the same as in program 2-a.)		
	019	subt	002	$E_{3(j+1)} - E_{3j}$
(4)	020	tcn	027	$\lvert E_{3(j+1)} - E_{3j} \rvert - \delta$
(4)	021	subt	005	(if this is negative, precision is satisfied)
(4)	022	tcn	029	
(5)	023	clear		
(5)	024	add	006	
(5)	025	store	002	
(5)	026	tcu	010 →	(Return to next iteration)
	027	add	005	$-\lvert E_{3(j+1)} - E_{3j} \rvert + \delta$
	028	tcn	023	(if negative, precision not satisfied)
(6)	029	clear		
(6)	030	add	006	
(6)	031	po		
(6)	032	stop		

NOTE: Part (4) of program 2-a, namely the decision or branching operation, is replaced by the following sequence of commands starting with command 019. Assuming monotonic convergence, suppose that we do not know whether E_{3j} is approaching the final value from above or below, hence, provision must be made for either positive or negative sign for the difference, $(E_{3(j+1)} - E_{3j})$.

that the solution is within amount δ of the true value, but an appropriate δ can be chosen so that this criterion produces the answer to the desired precision.

The "yes" or "no" decision programmed at cells 020 and 021 again employs an intentional overflow of the accumulator and the tcc command. This particular branching operation can be accomplished another way, utilizing the tcn command (transfer control, if (A) is negative), as above.

This type of test for convergence is facilitated in some computers by availability of the orders: "add absolute" and "subtract absolute." In these, the sign in memory is ignored and only the positive absolute value of the operand is added to or subtracted from $|(A)|$. Thus, the need for testing for the sign of $(E_{2(j+1)} - E_{2_j})$ is eliminated.

SUMMARY

THE EXAMPLES of the foregoing section have illustrated the reduction of a few simple computational problems to a sequence of commands. It is often possible to break up a much more extensive computation into smaller parts so that the programming consists of reducing small reasonably simple segments of the over-all computation to appropriate sequences of commands, such as has been done in these examples. For this process, the formulation of the problem in the form of a flow diagram plays an important part.

Scaling of data has been ignored in the examples here, though this is an important consideration in practical applications. Many modern computers include in their order codes the logical operations of "shift left" and "shift right." These permit shifting digits in the accumulator either to the left or right by any desired number of places. These operations permit programming of the decimal point at positions other than at the left-hand end of the data word. In this connection, it probably should be pointed out that, unlike the sample computer described, most machines have an accumulator with digit positions double the word length, so that significant figures are not lost in multiplications. Another procedure available for taking care of scaling difficulties is to program "floating decimal point" computation. This greatly extends the range of numbers which can be handled without overflows, but at the same time it reduces the speed of computation.

The rather restricted mathematical ability of the computer, limited essentially to the four operations of arithmetic, can be extended greatly by the use of subroutines. For example, the operation of extracting the square root may be required frequently during the course of a computation, but this operation is not available in the order code. Furthermore, if the square-root operation were to be programmed over and over at each point in the computation where this operation is required, too much memory space might be required for the program. The use of a square-root subroutine avoids this difficulty, for the operation can be programmed once in such a way that this one subprogram or subroutine can be entered from any point in the main program, and the subroutine itself generates the address for return to the appropriate point in the main program after the square-root computation is completed. Once a subroutine is written for a given machine, the programmer need not concern himself with its details, and in effect it can be used as essentially an addition to the order code of the machine.

A brief survey of programming processes and principles such as this cannot be complete without defining another term common to the art, namely, "debugging." It has been said that in a program of more than ten words in length, one can be fairly confident that at least one mistake will be made the first time it is written. Debugging a program consists of locating and correcting mistakes made by the programmer and, in a long involved program, can be a frustrating experience. In attempting to communicate with a computer through the process of writing a program, the programmer must remember that the machine will execute with high speed and precision, as well as with faithful moronic stupidity, every blunder and mistake that is contained in the program.

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Solving Thermal-Circuit Problems with Computers

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THE INDUCTION MOTOR DESIGNER has always had to determine the temperature level of critical points within a motor because high temperatures result in shorter motor life and excessive motor failures. The thermal circuit is one means of calculating motor temperatures that has been available to the designer for many years, but has not been used to any great extent because the time required to obtain solutions from the circuit was much too long. The rapid development of computers and computer techniques in the last five years has made the use of thermal circuits much more attractive to the motor designer.

A thermal circuit is a method of representing the significant heat-flow paths of a motor by choosing appropriate thermal resistances to connect temperatures of various parts of the motor. From the fundamental equations of heat flow in one dimension, thermal resistance is defined as

$$R=\frac{\theta_1-\theta_2}{q} \tag{1}$$

where θ_1 and θ_2 are temperatures at two separate points, and q is the heat flow between θ_1 and θ_2. The relationship for thermal resistance is analogous to Ohm's Law in electric circuits, thus permitting use of a d-c network to solve thermal circuits. Currents and voltages in the direct-current network represent heat flows and temperatures within the motor, respectively. Thermal resistances take two basic forms

$$R=\frac{L}{kA} \quad \text{and} \quad R=\frac{1}{hA} \tag{2}$$

where A is the cross-sectional area perpendicular to the heat flow, k is the thermal conductivity, h is a heat transfer coefficient, and L is the effective heat-flow path length.

A thermal circuit is constructed by dividing the motor into a sufficient number of sections to describe adequately the heat-flow paths and temperature distributions in the motor. Each section must then be connected with the correct thermal resistance. Normally, the effective heat-flow path length is chosen as the distance between mean temperatures of two sections. Resistances from motor surfaces to the cooling fluid and between two surfaces in contact are represented by the form $1/hA$.

Many motor applications require the motor designer to evaluate motor temperatures where steady-state conditions do not exist. When the motor temperatures are changing, heat storage is represented in the thermal circuit by a capacitor from the mean temperature of the section to ground. The capacitor is of the form $C=\rho cV$, where V is the volume of the section, ρ is the density, and c is the specific heat of the material in the section.

The inclusion of capacitors in the circuit to allow analysis of transient temperatures in the motor makes thermal-circuit solutions much more difficult and requires computing techniques that are quite different. In either case, the circuit is solved by writing a heat-balance equation for each junction point. The steady-state circuit has a set of simultaneous linear equations that must be evaluated. The transient circuit will have a set of first-order differential equations requiring a solution.

The steady-state thermal circuit can be solved quite simply on a direct-current network analyzer or on a digital-type computer. The network analyzer is low in initial cost, is simple to operate, and requires no long setup or programming time. The digital computer requires a long initial programming period, but has the advantages of being much faster and of being able to calculate all the circuit parameters in addition to solving the circuit equations. Iteration techniques are sometimes employed in thermal circuit solutions and are performed most conveniently on the digital computer.

The transient thermal circuit can be solved on any computer capable of solving a set of first-order differential equations. An electronic differential analyzer is one analogue-type computer which is well suited for thermal circuit analysis. The d-c network analyzer also can be employed by adding to the analyzer used for steady-state solutions a set of variable capacitors, constant-current sources, and multichannel recording equipment to record circuit temperatures as a function of time. Because of its high speed, reliability, and versatility, the digital computer is replacing analogue computers in many areas. The transient circuit can be solved on the digital computer by choosing small intervals of time over which steady-state conditions can be assumed. A complete solution is obtained for each interval of time. There are many available methods by which numerical integration of differential equations can be performed. The thermal-circuit designer must choose the method that best fits his needs.

The present status of thermal circuits for induction motors can be summarized very briefly. The need for accurate temperature calculations in induction motors is more important now than it has ever been. The computers needed to solve the equations of large thermal circuits are now available. The methods and techniques for setting up these circuits are, for the most part, not new. Upon completion of thermal-circuit refinements and heat-transfer coefficient improvements, it is anticipated that the thermal circuit will become one of the most valuable tools of the motor designer.

Digest of paper 56-922, "The Application of Computers to the Solution of Induction Motor Thermal Circuits," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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A New 115-Kv 1,000-Mva Gas-Filled Circuit Breaker

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THERE ARE MANY APPLICATIONS for a simple, reliable 115-kv circuit breaker having moderate interrupting capacity. Such applications include radial circuits, loop circuits, capacitor switching, and other related circuits. Designed to meet these requirements, the type *1150-SF-1000* circuit breaker utilizes the unique arc-interrupting and insulating characteristics of sulfur hexafluoride (SF_6) gas.

The three porcelain-clad poles containing SF_6 at 45 pounds per square inch gauge are mounted on a frame (Fig. 1). A standard pneumatic operating mechanism provides the necessary closing energy, and is connected through a bell crank to a horizontal operating rod which is connected to a horizontal lever at the base of each pole, thus providing rotational motion to the interrupter drive. The lower half of the pole unit provides isolation from ground and contains the interrupter drive shaft, and the upper half of the structure contains the interrupter.

The interrupter consists of three curved, double-armed, U-shaped moving contacts mounted on a rotating shaft which mate with six stationary contacts to provide six breaks per phase—each in a horizontal plane and located one above the other. These breaks are designed to provide efficient interruption of fault currents of over 1,000 mva and restrike-free performance on magnetizing and capacitive currents. Improved voltage distribution among the six breaks of each pole is obtained by providing shunt capacitance as a voltage divider.

The interrupter unit may be easily disassembled from the pole unit for examination by removing the top cap and lifting the interrupter out of the porcelain. The pole unit is hermetically sealed and exacting leak tests are conducted in the shop to insure dependable leak-free service. The assembly also includes a pressure gauge which is visible from the ground, a gas filling valve, and a pressure-relief diaphragm to conform to standard design practice.

The breaker was tested extensively to determine both its fault and capacitive current interrupting abilities. It has been subjected to normal verification tests which include fault interrupting, closing and latching, momentary and 4-second, 60-cycle and impulse voltages, temperature rise at rated continuous current of 400 amperes, and a mechanical life test.

Under the severe laboratory test circuit conditions the interrupting time ranged between 2.5 and 3.5 cycles. Tests were also made at full 115 kv with the gas pressure reduced by 25 per cent in which the maximum current rating was interrupted successfully.

Approximately 400 capacitor switching tests, on both single and parallel banks, of currents ranging from 24 to 300 amperes at 66 and 88 kv, have established the restrike-free performance of this breaker and its suitability for such service.

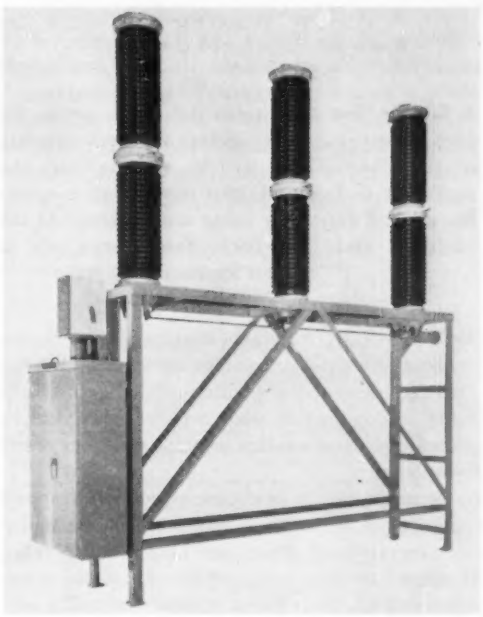

Fig. 1. Side view of 3-pole breaker on life test.

A life test of over 1,500 unit operations, considerably more severe than that specified by the American Standard Association or National Electrical Manufacturers Association for this breaker rating, has established the mechanical suitability of the breaker for the severe service encountered on capacitor-switching duty.

A new type of circuit breaker having 1 million kva interrupting ability using sulfur hexafluoride as an interrupting medium has been developed and completely verified for 115-kv service. In addition, the breaker has the following outstanding characteristics:

1. Restrike-free performance of interrupting fault and magnetizing currents and switching single or parallel banks of capacitors.
2. Rugged and dependable design which makes it suitable for large numbers of operations with minimum maintenance.
3. Simple construction with all parts easily accessible.

Digest of paper **56-991**, recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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A Control System for Research-Type Nuclear Reactors

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A flexible, low cost, industrial servo system for providing control for nuclear research reactors is described. The article shows how the controller is designed, how this design executes the control functions using temperature as the variable, and how these functions apply to reactor kinetics.

THE SEARCH for more compact, efficient, and inexpensive control systems for nuclear research reactors has led touse of the position-adjusting-type (P.A.T.) controller in conjunction with the reactor control rod or rods to maintain neutron flux levels as steady as possible at the beam holes.

This control system is an electric system. Its input signal is received from the neutron flux recorder–controller. It provides proportional, reset, and rate actions. The controller output actuates a rugged industrial type drive unit for regulation of the reactor control rod. The over-all system is shown schematically in Fig. 1.

The nuclear reactor flux level is sensed by a neutron flux detector, which is an ion chamber sensitive to neutrons and compensated so that the chamber is insensitive to gamma radiation over the desired range of operation. The output of the chamber is amplified by the chopper-stabilized micromicroammeter. The range of this chopper-stabilized d-c amplifier is 10^{-9} amperes to 5×10^{-4} amperes full scale, in 18 steps. Calibration, gain stability, and zero stability are such that an accurate and reliable indication of reactor neutron level is obtained. The output of this amplifier provides the input signal for the recorder–controller.

The flux level recorder–controller includes a control slidewire which rotates concurrently with changes in recorded flux level. A control point setter permits manual adjustment of the control slidewire contact relative to the control slidewire. The error signal from the control slidewire is of one polarity or the other depending upon whether the deviation of the neutron flux level is above or below the control point and is of a magnitude proportional to the departure from the control point. The error signal is fed to the control unit. The control unit directs the positioning of the rod drive unit actuator and provides the proportional and reset functions, as will be described later. The rod drive unit consists of a reversible capacitor-type motor which, through suitable gearing, actuates the control rod in the proper direction and to the proper extent to regulate the neutron flux at the desired level. A slidewire on the drive unit provides a position feedback into the control unit, as will be more fully described later. This same slidewire may serve to provide indication of rod position.

Proportional control action and reset control actions are those normally used for reactor control. Rate or derivative control action, although available in the standard control unit, is normally not used for reactor control, because of the short time lags involved in the reactor response to changes in control-rod position. Proportional control action and reset actions will be briefly discussed and defined. The circuits which provides these actions will then be described. The control system is of the general-purpose type and is suitable for the control of other quantities as well as for neutron flux level.

PROPORTIONAL POSITION CONTROL

THIS CONTROL ACTION, as its name implies, produces a final control element position which is directly related to the magnitude of the variable under control. For purposes of describing the controller actions reference will be made to a typical temperature control. Stated mathematically, proportional control may be defined as:

$$Y = -100\,\theta/A,$$

where

Y = Change in valve position (per cent of full travel)
θ = Change in temperature (per cent of controller scale)
A = Proportional band (per cent of scale)

The minus sign in the equation for Y signifies that, for example, in a typical temperature control the controlled valve closes as the temperature rises. Thus, the temperature variations and the resulting controller response can be said to be 180 degrees out of phase.

The proportional band is usually defined in percentage of controller scale. For a 100 per-cent proportional band, for example, the valve is full stroked when the temperature changes by an amount equivalent to the full scale of the instrument. A 10 per-cent proportional band setting, on the other hand, produces full valve travel for a change in temperature corresponding to 10 per cent of the instrument range.

Proportional position control, although entirely satisfactory for many processes, has one inherent weakness on most processes, that of load offset. For example, if the valve on a temperature control is controlled half open for a

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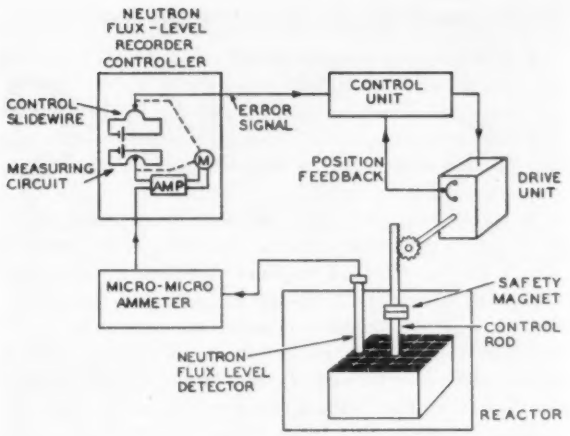

Fig. 1. Schematic diagram of over-all control system.

temperature of 200 F, the proportional control action cannot provide for a new load situation in which the valve must be more or less than half open for a temperature of 200 F. Upon changes in demand, the valve assumes a new position to meet that demand. This new valve position can be secured only at the expense of a change in the controlled temperature.

This undesirable characteristic of proportional position control, which produces a different temperature for every change in load demand, is particularly objectionable where the characteristics of the process require the use of a wide proportional band and where, consequently, a larger change in temperature occurs for a given change in demand. For such processes, or for other processes where a definite control point rather than a control band is needed, a second control function is used in combination with proportional position control. This control is termed "automatic reset."

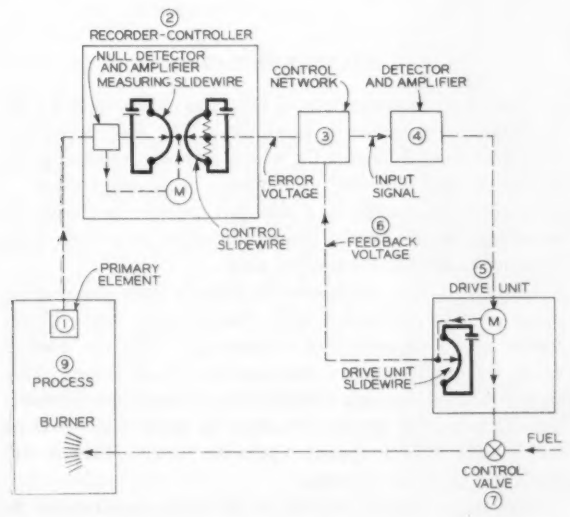

Fig. 2. Series 60 electric control.

AUTOMATIC RESET

THIS TYPE OF CONTROL produces, in effect, an automatic reset of the proportional band with respect to the set point so that the control-valve position will be properly shifted with respect to recorder-pen position; hence, temperature may be brought back to the set point regardless of changes in load demand. That is, automatic reset produces a slow, continuous change of valve position which persists as long as the temperature is off the set point.

Reset action recognizes only how far temperature is off the set point. It does not recognize the trend of temperature change. Unlike proportional action, which opens the valve for a downward trend in temperature and closes it for an upward trend, the reset action acts to move the valve at a given rate in the same direction for a given deviation of temperature on one side of the control point regardless of trend.

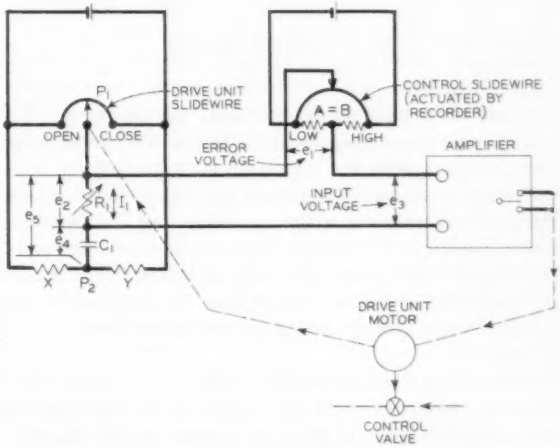

Fig. 3. Proportional position control circuit.

It is of interest to note that automatic reset, because of its integrating action, is out of phase with the temperature and lags the temperature cycle. For example, on sinusoidal variation in temperature, a corresponding sinusoidal variation in reset control action is obtained which lags the temperature cycle by 90 degrees.

Because of the out-of-phase action of reset, there is an inherent instability which tends to cause cycling of the control. However, when reset is used in combination with the stabilizing effect of proportional action, stable control can be secured.

The speed of reset action is generally defined in repeats per minute; that is, the number of times the proportional valve action is reproduced by the reset action in one minute.

Where measuring and control lags are short, relatively fast reset rates may be employed; where lags are longer, the reset speed must be reduced to avoid hunting.

The major components of the series *60* electric control are shown in Fig. 2. An error signal is developed whenever

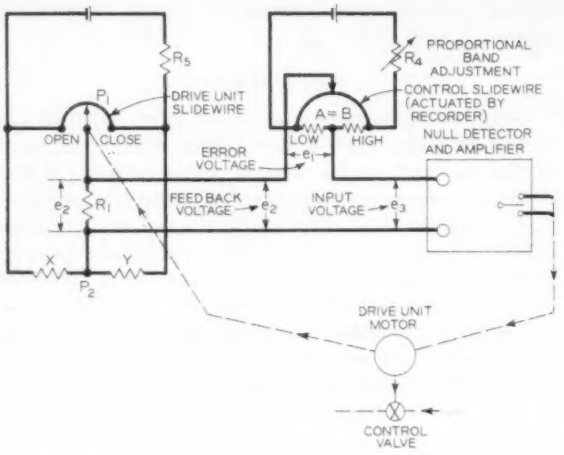

Fig. 4. Automatic reset circuit.

the controlled variable departs from the set point. The control unit uses the error signal to provide proportional, reset, and rate actions.

Primary element 1 transmits the input signal to the standard recorder–controller 2. This unit has a motor which positions the control slidewire to a position corresponding to that of the measuring slidewire. Any motion of the control-slidewire contact from its midposition produces an error voltage, which is transmitted to the control network 3.

The control network compares the error voltage and a feedback voltage from the drive unit 5 to develop a second error signal, which is the input signal to the detector–amplifier 4. If the input signal to the detector is other than zero, the corresponding output signal actuates the motor of drive unit 5, thus generating a feedback voltage 6 by movement of the drive unit slidewire and a corresponding mechanical repositioning of the control valve. The change in input restores the process to such a condition that the error voltage is reduced to zero.

The system of Fig. 2 represents two closed-loop systems—one, the control system only, including items 3, 4, 5, and 6; the other, including control valve 7, the burner 8, the process 9, primary element 1, and recorder–controller 2.

Fig. 5. Plug-in control unit.

PROPORTIONAL POSITION CONTROL CIRCUIT

THE FUNCTIONING of the proportional position control circuit is shown in simplified form in Fig. 3.

The control slidewire which is positioned by the recorder generates an error voltage e_1 when the slidewire contact is at any position other than its midposition. This is because resistors A and B are equal.

If e_1 is other than zero, then unless e_2 is equal in magnitude to e_1 and of opposite sign, the input voltage e_3 is other than zero. The detector and amplifier then produce an output voltage to operate the drive-unit motor in one direction or the other. As the drive-unit motor operates, it moves its slidewire contact with respect to its slidewire so that a voltage difference between P_1 and P_2 appears across resistor R_1. When this feedback voltage e_2 is equal and opposite to error voltage e_1, then input voltage e_3 becomes zero and the drive-unit motor stops.

If the control slidewire contact is at its midposition ($e_1 = 0$), then the drive-unit slidewire is at its midposition (e_2 and $e_3 = 0$). Likewise, as temperature departs from this midposition and generates a voltage e_1 proportional to this departure, the valve slidewire contact must be moved to generate a voltage e_2 proportional to the drive-unit position in order to maintain input voltage e_3 at zero. Consequently, proportional position control is obtained.

The width of the proportional band is a function of the relative voltages on the control and drive-unit slidewires. For example, if each slidewire has 1 volt across it, then a 1-to-1 ratio would be established. Full travel of the control slidewire would then produce full travel of the valve slidewire, giving a proportional band of 100 per cent—assuming that the width of the control slidewire corresponds to full recorder scale.

As resistance R_4 is decreased by turning the proportional band-adjusting dial so that the voltage across the control slidewire rises from 1 volt to 10 volts, then 1/10 of the control slidewire travel generates the 1-volt signal required to full stroke the drive unit. Accordingly, the proportional band is then 10 per cent.

AUTOMATIC RESET CIRCUIT

BY A SIMPLE MODIFICATION of Fig. 3, as indicated in Fig. 4, automatic reset action is produced. The modification is the addition of capacitor C_1, which makes it impossible for the drive-unit slidewire to maintain feedback voltage e_2 to rebalance e_1 except by a slow but continuous change in slidewire position in the proper direction to restore temperature exactly to the control point.

Assume that the temperature departs from the control point as a step function and observe what takes place. Upon a step departure of temperature from the control point, the error voltage e_1 increases to a fixed value. This signal, applied through the amplifier, immediately actuates the drive unit to generate voltage e_2 until it is equal in magnitude and of opposite polarity to e_1. This is the proportional position action.

Note that e_2 is generated by an IR drop across resistor R_1 due to the flow of current I_1. The current I_1 flows because of the difference in voltage e_b which exists between potential

Fig. 6. Nuclear reactor simulator.

points P_1 and P_2. Since this path includes capacitor C_1, any voltage e_4 on the capacitor influences the magnitude of current I_1 for a given potential e_5. It is evident that as current I_1 flows through C_1, a potential e_4 is built up on capacitor C_1 which opposes the flow of current. Thus, $I_1R_1 = e_2 = e_5 - e_4$. Hence, as e_4 increases, e_5 must increase to keep e_2 constant. Therefore, the drive unit must move continuously at a slow speed to increase e_5 at the same rate that e_4 is increasing, in order to maintain e_3 at zero.

Linear Reset through Entire Range of Valve Action. The rate of increase of potential e_4 is constant for a given departure from the control point, inasmuch as $E = Q/C$, and the charge Q on capacitor C increases at uniform rate because of constant current I_1. The increase in e_5 similarly is a linear function, because e_5 is related to e_4 by an assumed constant difference e_2. Therefore, for a given temperature deviation, the speed of valve action due to reset remains constant throughout the entire valve range.

Reset Speed Proportional to Deviation. Note that the speed of valve action due to reset is proportional to the magnitude of the deviation of temperature from the control point, because as e_1 becomes larger with greater deviation, charging current I_1 must be larger to develop a correspondingly large I_1R_1 drop to balance e_1. This increased current charges C_1 at a correspondingly faster rate and causes e_4 to build up proportionally faster. Accordingly, voltage e_5, which is determined by the drive unit slidewire contact position, must be increased at a similar faster rate.

Reset Adjustment. Adjustment of reset is accomplished readily by a variation in the value of resistor R_1. Referring to Fig. 4, it is apparent that if R_1 is halved, I_1 must be doubled to produce the same I_1R_1 drop, e_2. The increased current charges C_1 at twice as fast a rate as before. Therefore, the reset speed is doubled. A wide latitude of reset adjustment can thus be provided by varying R_1 from a very low value to an extremely high value.

NUCLEAR REACTOR SYSTEM PECULIARITIES

A NUCLEAR REACTOR has the particular property of having an output which is basically unstable. It remains constant from one rod position only, i.e. the critical point. Withdrawing the rod slightly from the critical position will make the reactor activity increase continuously until the rod is inserted to its original position. Inserting the rod slightly from the critical position will make the reactor activity decrease continuously until the rod is withdrawn to its original position.

The rate at which reactor activity increases or decreases is a logarithmic one and is referred to as the "period," or more specifically, the time in seconds for the pile activity to change by amount e, or $1/e$. The further the rod is displaced from its critical position the shorter the reactor period will be.

Change in reactor activity is the result of change in

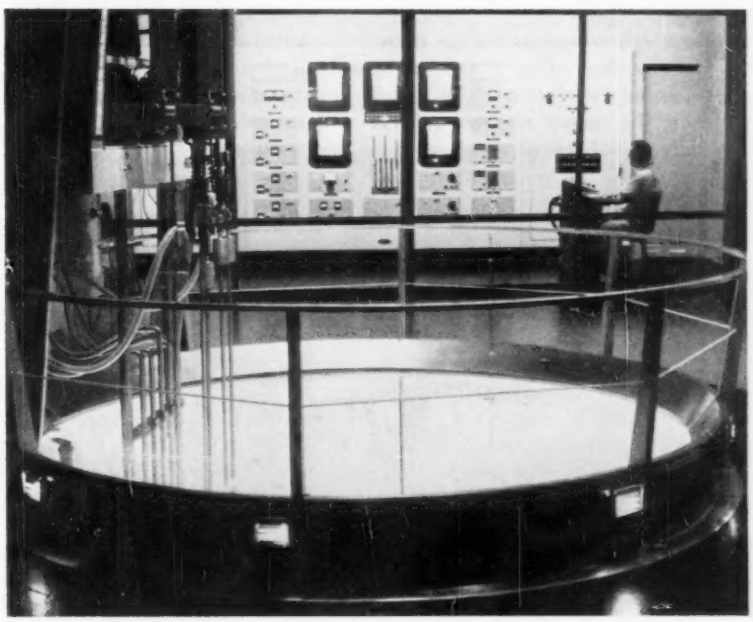

Fig. 7. Operating pool-type reactor.

activity of several types of neutrons which may be roughly divided into two classes: prompt neutrons and delayed neutrons. When the rod position is changed, there is a substantially immediate change in the release of prompt neutrons and shortly thereafter in the release of delayed neutrons. It is this delayed neutron reaction which results in the reactor being controllable.

The effect of a given control rod movement is proportional to reactor power level, that is, at low power levels a given ΔK will produce a slow change in reactor output, whereas at high power levels the same ΔK will produce a correspondingly faster change in power output.

This immediately suggests the desirability of changing the proportional-band settings as a function of power level if optimum control response is to be achieved. This, in particular, would act to prevent undesirable control oscillation at the higher power levels. Automatic adjustment of the proportional-band setting may be achieved by mounting a suitable voltage divider on the flux level recorder–controller to widen the proportional band suitably as the flux level increases.

A very useful auxiliary control effect may be obtained by incorporating a signal from the period channel into the control system in such a way that the rod is automatically positioned as a function of both reactor period and neutron flux level so that the period will not become shorter than a preset value. This is particularly helpful in bringing the reactor up quickly and yet safely to some new higher operating level, especially when coming up from very much lower power levels.

From what has been said in the foregoing about the effect of rod position on reactor activity it will be apparent that the proportional control action will largely suffice to maintain activity at the desired level due to the integrating action of the reactor itself.

However, there are several effects which occur in the reactor which necessitate the use of the reset action of the automatic control. One of these effects is the temperature coefficient of the reactor. This usually has the effect of requiring the control rod to be further out to maintain criticality at higher load as compared to its critical position at lower loads. Accordingly, to maintain reactor activity at the set point, the automatic reset function comes into play and shifts the rod to any position required to obtain the desired reactor output.

The other effects which require reset action to hold the desired reactor output are fuel burnup and fission-product poisoning. Because of these effects, a change in rod position will be required to hold reactor output at the desired level. The reset action produces this shift in rod position.

Fig. 5 shows the plug-in control unit removed from its case. Change from automatic to manual control is provided by the AUTO-MAN switch. When on MAN, the 3-position switch permits regulation of the rod position manually to raise, lower, or stop. The amber signal lights when the rod is lowering and the red lights when the rod is raising. The position indicator shows the rod position at all times. Other adjustments which are available when the controller case is open permit adjustment of the proportional and reset responses to suit the process. Proportional band is adjustable from 0 to 500 per cent of recorder range, and reset is adjustable from 0.01 to 100 repeats per minute.

The rod drive unit is powered by a reversible, capacitor-type motor. All shafts are supported on ball bearings, and the unit is permanently lubricated.

Although the control system has been shown including a neutron flux level recorder–controller, if a recorder is not desired, the amplified signal from the flux level detector may be fed directly to the control unit to provide similar control action.

An excellent method of studying nuclear reactor control behavior is by utilizing analogue computer techniques. Design studies can be made on new systems without the need of a reactor.

The nuclear reactor simulator shown in Fig. 6 is a device used for teaching fundamentals of reactor kinetics as well as providing a visual display of an operating reactor core and associated instrumentation. This simulator can be used to perform many useful functions, among them being checks and tests on reactor control systems and critical experiment tests. This simulator was first introduced at the United Nations Conference on Atomic Energy held in August 1955 at Geneva, Switzerland.

Fig. 7 is a view of the operating pool-type reactor installed by the United States Government at Geneva and shows the reactor control room with the pool and rod actuating device in the foreground. The Leeds and Northrup Company P.A.T. control system was used to regulate the neutron flux level (power output) of the reactor.

CONCLUSION

THE PROBLEM of nuclear reactor control is simplified in many respects by the use of a system that has proved itself in the control field for many years. Reliability is of prime importance in the control of a nuclear reactor. The reasons, of course, are obvious. The industrial servo system which has been discussed here is such a system.

Flexibility, ease of service, and low cost are factors which must be considered in the design of a reactor control system capable of being changed to keep pace with the rapid advances being made in both the research and power reactor field.

Tests on Traveling-Wave Tubes

An extensive program is under way at Bell Telephone Laboratories to develop traveling-wave amplifier tubes for communications applications. Tests are being conducted on an experimental tube designed to provide 5 watts output with a bandwith of 500 mc in the 6,000-mc band.

This particular test is designed to detect and measure a certain type of nonlinearity in the tube. A 6,000-mc amplitude-modulated signal is fed to the traveling-wave tube. If nonlinearity exists, some of this amplitude modulation will be converted to phase modulation, which can then be detected in the amplified signal at the output of the traveling-wave tube.

In-Service Winding-Temperature Measurement

P. K. PAVLIDES
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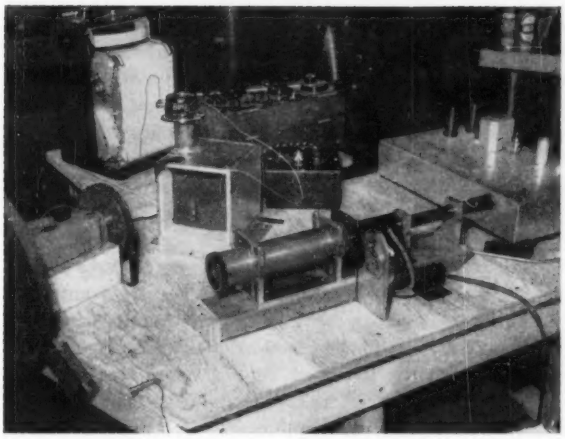

Fig. 1. Close-up view of test table. *Left to right:* Time-sharing device with mirrors, Esterline recorder, standard oven, optical system (*foreground*), and chassis containing the necessary circuits.

DURING 1954, a radiation pyrometer was developed by the Franklin Institute in conjunction with the Philadelphia Electric Company. It was constructed for the purpose of measuring in-service temperatures on the amortisseur windings of the 25-cycle single-phase generators of two large frequency changers. The temperature measurements which were made with this instrument were the latest in a long series of investigations in connection with recurrent amortisseur winding failures apparently caused by a combination of temperature, stress, and time.

When the most recent winding failure occurred and a newly designed winding was installed, it was the manufacturer's opinion that an appreciably lower operating temperature should be obtained. Inasmuch as, from experience, it was certain that it would be only a matter of time until another new amortisseur winding would be required for the other machine, it was, of course, highly desirable to know whether the expected temperature improvement was achieved. This could be determined only by comparative tests on the two identical machines.

It was at this point that the possibility of developing a radiation pyrometer was first discussed with the personnel of the Franklin Institute. It developed that they had some previous experience with an Eastman Kodak Company Ektron cell which they felt would be a suitable detector. Accordingly, arrangements were made for the development of a suitable device for use with the two frequency changers.

As finally developed, the pyrometer consisted essentially of a radiation detector, an optical system to control and transmit the radiation to the detector, recording apparatus, and amplification and conversion equipment to obtain a suitable signal for the particular recorder being used. Auxiliary apparatus included calibration equipment and a "time-sharing" device so that calibrating data would automatically be recorded as a part of the temperature record. The final test setup is shown in Figs. 1 and 2.

By recording amortisseur winding temperature on either an Esterline recorder or a magnetic oscillograph equipped with means for obtaining a high-speed photographic record, and at the same time recording generator loading data on synchronized Esterline recorders, it was possible to obtain temperature readings at any desired instant, and correlate these readings with the load data.

The final test results permitted a comparison of the temperatures obtained on a redesigned winding installed on one of the machines with the temperatures obtained on the winding of the other machine, which was of the previous design. Preliminary examination of the test results indicates that for identical load conditions an improvement of approximately 20 to 25 F has been accomplished as a result of the design changes. Thus, the manufacturer has been able to verify his temperature calculations and recommend an additional design change (to be incorporated in the new winding for the second machine), which is expected to reduce the amortisseur winding operating temperature by an additional 10 F.

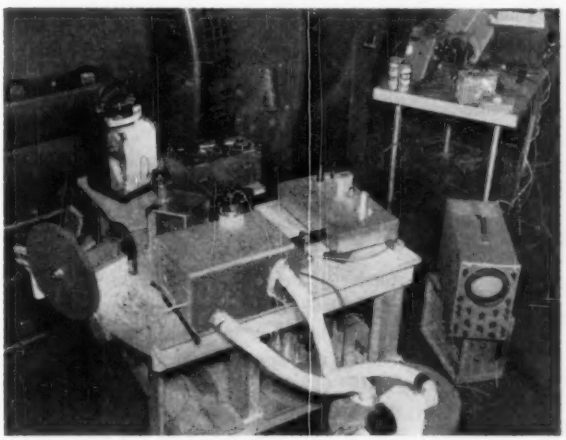

Fig. 2. General view of test setup ready to operate. In foreground is the cooling device. At right is the oscilloscope and to rear is the magnetic oscillograph.

Digest of paper 56-925 "In-Service Temperature Measurement of the Amortisseur Winding of Large Frequency Changers," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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Nonlinear Control System Response to Random Signals

P. N. NIKIFORUK

IN GENERAL servomechanisms are nonlinear, the linear type being only a special case. Consequently, for a number of years a considerable amount of time has been devoted to the study of nonlinearities in control systems. Until recently these studies have been limited to the analysis of systems with inherent nonlinear characteristics. More recently, however, interest has arisen in control systems using nonlinear characteristics for producing distinctive and desirable features of system behavior.

A particular nonlinear system which was considered of interest is one incorporating the hard-spring characteristic.

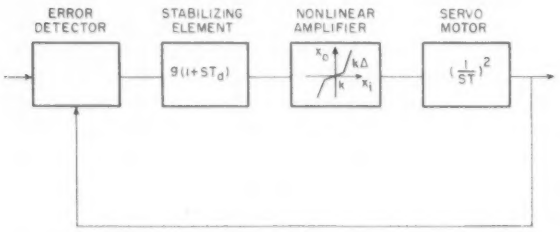

Fig. 1. The basic system.

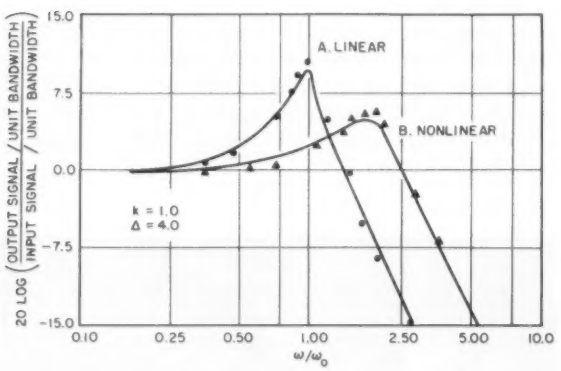

Fig. 2. Typical responses to a random signal. Theoretical responses are shown by full line; experimental responses are shown by points.

The particular form of the hard-spring characteristic considered is one consisting of three straight lines, the gain of the element incorporating it increasing from k to $k\Delta$ (where $\Delta>1$) whenever the signal at the input to this element exceeds a critical value $\pm V_c$.

Previous work has revealed that the introduction of this characteristic into a closed loop system of the type shown in Fig. 1 results in several distinctive features of system behavior. The first is that the introduction of this characteristic actually decreases the response time to transient inputs. The second is that for sinusoidal excitation signal a sharp discontinuity in the gain–frequency characteristics arises under certain conditions of signal amplitude and degree of damping. This discontinuity perseveres in the presence of noise, provided that the latter is not too great. It was thought that a similar system, properly designed, might serve as a very low pass filter with a sharp cutoff.

To evaluate the merits of such a system with regard to its filtering capabilities, an analysis has been made to determine its response to a random signal. Because the system is one in which the harmonics and other distortion components generated by the nonlinear element are severely attenuated by the filtering action of the servo motor, the theoretical analysis is based upon a quasilinear approximation technique. In this, the nonlinear element is replaced by a quasilinear amplifier in which the gain is such that the mean-square error made in this approximation is a minimum. From this, two sets of curves are calculated. The first set relates the output of the nonlinear element to its input. The second set relates the input of the nonlinear element to the input of the system. For a particular set of conditions the operating point of the system is determined by superimposing the two sets of curves, the appropriate intersection corresponding to the operating point of the system. Proceeding in this manner, the response of the system to a random signal is evaluated and is displayed in the form shown in Fig. 2.

In this figure, typical theoretical and experimental responses are shown. The linear response to a random signal of limited bandwidth is depicted by curve *A*. The nonlinear response to a random signal of the same bandwidth and an rms signal amplitude such that the ratio of the latter to V_c is approximately 4.6 is depicted by curve *B*. It has been found that the effect of keeping the signal bandwidth constant and increasing the rms signal amplitude is to produce an output response of increased bandwidth and decreased resonance peak. The effect of increasing the signal bandwidth while keeping the rms signal amplitude constant is to increase also the bandwidth of the response and to decrease the resonance peak.

For the range of parameters considered, and with the signals used, dual-mode operation did not take place. This is in contrast to that obtained for the same range of parameters with sinusoidal excitations. From this, it is assumed that filtering characteristics of this system are better for sinusoidal than for random inputs. Experimental measurements verified the theoretical analysis.

Digest of paper 56-924 "Response of a Particular Nonlinear Control System to Random Signals," recommended by the AIEE Committee on Feedback Control Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1–5, 1956. Scheduled for publication in AIEE *Applications and Industry*, 1956.

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Synchronization by Means of Multiplier Phototubes

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ONE METHOD of obtaining accurate synchronization of rotating components with electronic signals is by the use of multiplier phototubes. Accuracies of the order of 1 millimicrosecond have been obtained with this method. The synchronization signal is obtained by scanning a light beam, usually a slit image, across a slit located in front of the phototube. The scanning is done by reflecting the light beam from a mirror which is fastened to the rotating component.

As the object of the arrangement is synchronization, it is of great interest to know the amount of jitter introduced by the noise in the phototube. An attempt is made here to derive an expression for this jitter. Inasmuch as both the noise and the pulse rise time are intimately connected with the bandwidth of the phototube circuit, the bandwidth which is required for minimum jitter is also of considerable interest.

The jitter may be expressed in terms of the rise time and the signal-to-noise ratio of the synchronization pulse as follows:

$$\Delta t = \frac{T}{s} \tag{1}$$

where Δt is the jitter, T is the rise time, and s is the signal-to-noise ratio. This relationship can be ascertained with the aid of Fig. 1, which represents a synchronization pulse with superimposed noise. Equation 1 follows immediately from the similarity of triangles *ABC* and *CED*.

On the assumption of white noise, justified to about 10^8 cycles per second (cps), then

$$s = \frac{K}{\sqrt{\Delta f}} \tag{2}$$

where K is signal-to-noise at 1-cps bandwidth and Δf is the bandwidth of the associated circuitry.

It is assumed further that the "electronic rise time" T_e, i.e., the rise time in response to a perfect square pulse, is inversely proportional to Δf, or specifically that

$$T_e = \frac{0.35}{\Delta f} \tag{3}$$

and that the total rise time will be

$$T = \sqrt{T_o^2 + T_e^2} \tag{4}$$

where the "optical rise time" T_o is the time required to reach full illumination of the photocathode.

On the basis of these assumptions it is found that with given T_o, minimum jitter occurs when $T_e = T_o$ and that the jitter is then

$$\Delta t_{min} = 0.837 \frac{\sqrt{T_o}}{K} \tag{5}$$

Investigations into the origin of K show that in the usual applications only shot noise need be considered. Under these circumstances

$$K = K' \sqrt{\frac{\sigma L}{2e}} \tag{6}$$

where σ is the cathode luminous sensitivity, L is the incident light flux, e is the charge of the electron, and K' is a constant somewhat larger than unity taking account of shot noise at the dynodes and nonuniformity of gain across the photocathode due to imperfect electron focusing.

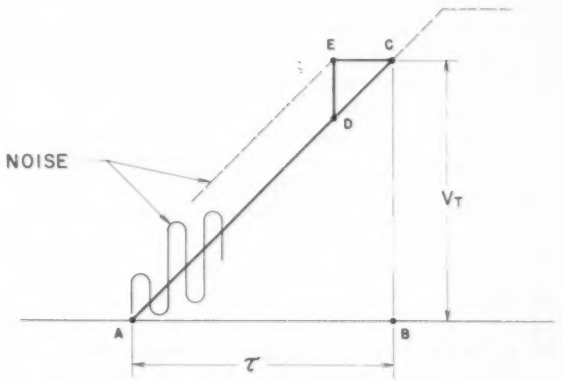

Fig. 1. Noise–jitter relationship.

In terms of the optical system used, the light flux reaching the photo cathode is

$$L = B \frac{A}{D^2} \eta h d$$

where B is the source brightness (candles per millimeter^2); A is the area of the exit pupil; D is the distance of this exit pupil (assumed coincident with the rotating mirror) from the phototube slit; h and d are height and width, respectively, of the slits; and η is the efficiency of the optical system.

With reasonable assumptions for η and K' it is then found that minimum jitter is approximately

$$\Delta t_{min} = \frac{5 \times 10^{-10} \sqrt{D}}{\sqrt{\omega \eta B A h}} \tag{7}$$

where ω is the angular velocity of the reflected beam.

Digest of paper 56-759 "Synchronization Accuracy Obtainable with Multiplier Phototubes," recommended by the AIEE Committee on Electronics and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25-29, 1956. Scheduled for publication in AIEE *Communication and Electronics*, 1956.

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Isolated Phase Telescoping Bus Duct

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Designed to fulfill the requirements of easy installation and convenient inspection, this new type of waterproof bus duct needs a minimum of gaskets. Over two years of extensive experimentation were necessary to complete this final design.

THE ISOLATED PHASE BUS has now become an important feature in central power station design. Because of its wide use, it is more important than ever that this bus be so constructed that it is easy to install, that it be convenient to inspect, that gasketing be kept to a minimum, and that the duct be waterproof. This is in addition to the usual electrical requirements. This article describes a new type minimum-gasket bus duct and the electrical problems associated with the new design. Gaskets are unwelcome necessities at best, and designers have gone to great lengths to eliminate them on all types of outdoor electrical equipment. Welding has replaced gasketing on some equipment, but many engineers feel that other equipment must be available for inspection. Such equipment is the isolated phase bus, where most engineers prefer the accessibility of a gasketed-type bus and reluctantly accept the water hazard which goes along with it. A further deterrent to the all-welded cover is the necessity for considerable field welding—an undesirable operation. Some bus installations use completely welded covers, but these are very few.

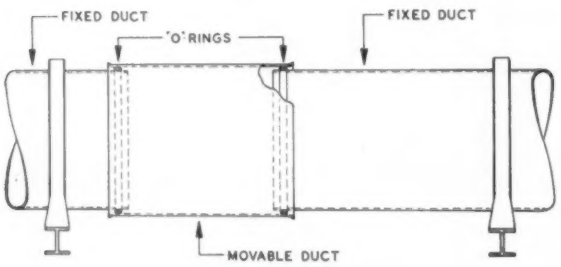

Fig. 1. Telescoping bus using "O ring" gaskets.

Planning a new design then resolved itself into a reduction of gaskets to as great a degree as possible, plus some means of reducing or eliminating the large number of bolts usually required to apply pressure to such gaskets. After many false starts and over two years of experimentation, a telescoping bus cover was designed where a movable part rolled on to the fixed parts with "O rings" between the two, as shown in Fig. 1. This was assembled by placing the right "O ring" at the right edge of the movable duct and moving the duct two units of length to the right, rolling the gasket in between the sections. Then the left gasket was positioned at the left edge of the movable duct and the duct moved one unit to the left. Because the "O rings" had to be compressed sufficiently to provide a tight seal, considerable difficulty was experienced in shifting the movable cover section back and forth, even with levers, and the design was finally abandoned. This effort was not wasted, however, as it resulted in the present design shown in Fig. 2.

CONSTRUCTION

ALUMINUM RING *R1* is shown in Fig. 2, into which the fixed duct section is welded. *G1* and *G2* are neoprene gaskets, *C1* and *C2* clamping rings, and *S* a movable aluminum slip ring. Fig. 3 shows these members in detail. The fixed and movable duct sections are constructed from aluminum sheets, seam-welded into continuous rounds or cylinders. Clamp *C1* connects the movable duct to the ring *R1*, effectively grounding it. Gasket *G2* insulates the movable duct from the next fixed position to reduce circulating currents. To open the duct for inspection, clamps *C1* and *C2* are released. Fig. 4 shows a close-up of this clamp in the partially released position. The clamp locks over toggle and the springs are used to apply continuous pressure, so that if any gasket relaxation should occur after years of service, the springs will be able to take this up. Movable ring *S* (Fig. 3) and gasket *G2* are slid to the left and the telescoping section can then be moved to the left, opening the duct for inspection. This entire operation can be done in a matter of a few minutes. Fig. 5 shows the telescoping section in the retracted position.

Gasket bolts are completely eliminated and gaskets are reduced to a minimum. Wherever possible, bus and insulators are assembled at the factory into elbows and straight sections of duct for rapid field assembly. A typical field installation is shown in Fig. 6.

COVER HEATING VS DUCT LENGTH

BUS COVERS heat from two causes: radiation from the bus itself, and circulating currents induced in the covers. The presence of circulating currents in isolated phase type covers has long been recognized. It is basic that a voltage will be induced in a closed circuit placed in a-c fields. The currents generated in the circuit are a function of the field

Full text of paper 56-989, "Isolated Phase Telescoping Bus Duct," recommended by the AIEE Committee on Power Generation and Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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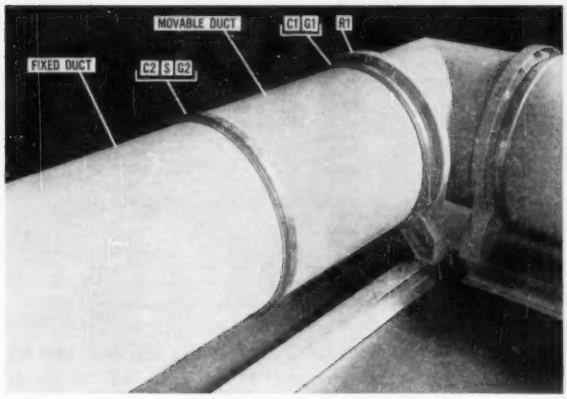

Fig. 2. Telescoping bus cover closed.

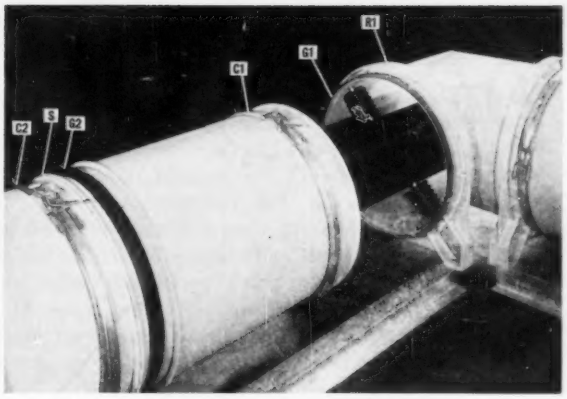

Fig. 5. Telescoping bus cover opened.

strength, frequency, distance from the field origin, phase spacing, conductance of the circuit, and the length of the circuit.

Several differences in the electrical pattern of the covers presented problems, as compared to the split and bolted covers previously used. One was the possible use of covers much longer than the usual 6 to 8 feet ordinarily used with split covers. Since the fixed cover is welded into a round, which gives it great strength, and this in turn is welded into rings which are bolted to beams and the assembly mounted as a unit, long duct lengths between rings can be used.

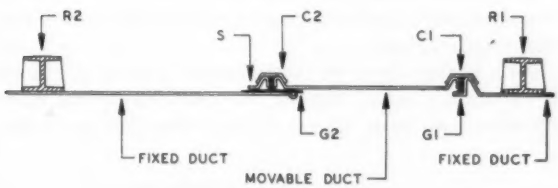

Fig. 3 (above). Cross-sectional detail of telescoping duct.

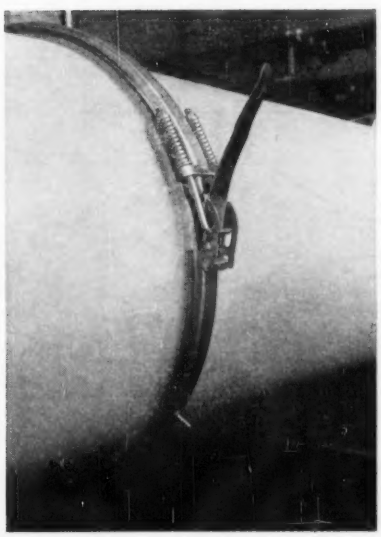

Fig. 4 (left). Cover clamp.

With the split covers it is very difficult to handle and mount a cover longer than 8 feet. In order to use this advantage of length, a careful investigation of the effect of cover length on the cover heating was made.

From investigations made six years ago, the effect of cover length on cover heating was thoroughly studied for the segregated phase type bus enclosure.[1] It was found that the heating in covers increased with cover length, but in a decreasing amount as the covers became longer. At that time little work was done on the isolated phase type enclosures, especially in cover section lengths greater than 8 feet. To study the pattern and relative magnitude of circulating currents in isolated phase covers, a mock cage made with $^1/_4$-inch copper rods was built to simulate a section of an isolated phase cover. As shown in Fig. 7, rods 59 inches long were placed at $4^1/_2$-inch intervals, parallel to the conductor, and two circular rods were used at each end in order to allow the circulating currents to close. The currents in each branch were read with a clip-on ammeter. When the mock grid was used on phase *A*, standard covers were used on phase *B* and vice versa, in

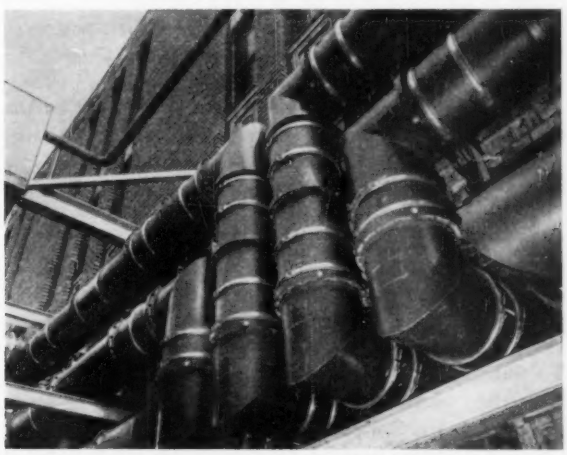

Fig. 6. Typical field installation of telescoping bus.

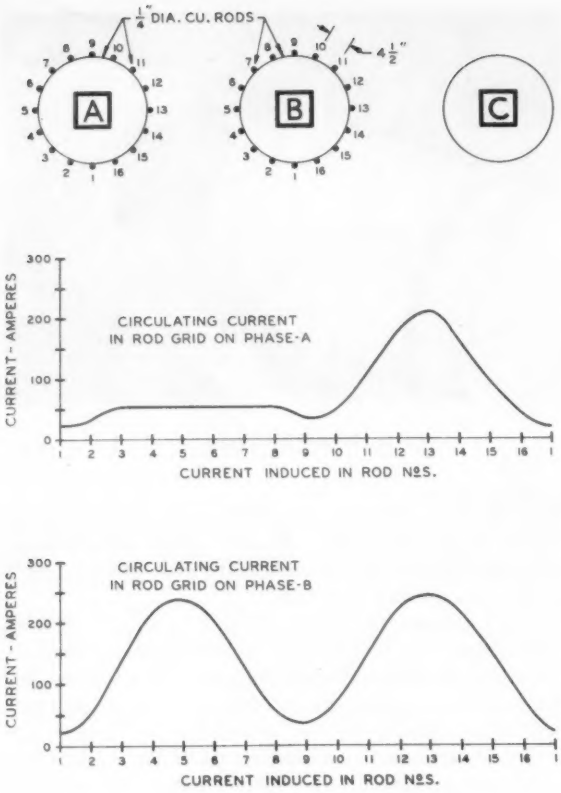

Fig. 7. Circulating current studies on mock covers.

order to disturb the usual field as little as possible. The values shown in Fig. 7 are the currents induced in the rods with 4,000 amperes in the main bus. In phase *B*, where the field is symmetrical, the maximum induced currents, 240 amperes, occur at the closest points to the adjacent *A* and *C* phases. In phase *A*, the field is not symmetrical and the maximum current occurs in the rod adjacent to phase *B* only. Note the symmetrical sinusoidal fluctuation of the current when the mock cover is on phase *B* as compared to the unsymmetrical behavior the current takes on when the mock cover is on phase *A*. Since the mock cover is influenced by the fluxes from the three phases, the currents induced in a single cover will be 3-phase in character. It is difficult to check the attained results by the rule "the sum of all currents entering a junction must equal the sum of all currents leaving a junction," since the angular relationship for the currents in each branch is not known.

It is reasonable to assume that the behavior of these induced circulating currents in actual solid aluminum enclosures is very similar to that of the mock setup, except instead of having a limited number of rods or current paths for a cover, there exists an infinite number. To illustrate as nearly as possible the magnitude of the circulating currents in an actual cover section, the setup as shown in Fig. 8 was used. Here, a section of the center phase of a 3-phase heat run setup was chosen to investigate circulating currents in the cover. The cover halves were

Table I. Cover Circulating Current vs Current in Mains

	Current in Bus	T-1	T-2
4-foot duct length	6000	540	530
	5000	460	450
	4000	360	370
	3000	260	280
	2000	180	170
	1000	70	70
8-foot duct length	6000	560	510
	5000	470	440
	4000	380	370
	3000	290	280
	2000	190	180
	1000	65	60

installed as shown with the edges in the top and bottom positions. A U-shaped copper strap, as shown by detail *A*, was used to join electrically the two cover halves. This arrangement lends itself nicely to measuring the closing currents in the cover. The cover halves were insulated from each other, so that all current flow would be forced through the copper straps only. The current readings were then taken with a clip-on ammeter.

Table I shows the circulating currents recorded at various main bus currents. From this table, the order of magnitude of the circulating currents in the covers became apparent. The little effect cover length had on increasing the magnitude of the circulating currents can be seen. Compare the results on an 8-foot cover section with that of a 4-foot section. At 6,000 amperes the circulating current at the top left side of the 8-foot section is 560 amperes. The corresponding point for the 4-foot section is 540 amperes. A plot of the circulating current vs main bus current for these two points is shown in Fig. 9. Note that a linear relationship exists between the circulating current and the main bus current.

As a further check on the influence of cover length on cover heating, actual sections were tested in 3-phase runs. These sections were 3 feet 6 inches, 4 feet 7 inches, 5 feet

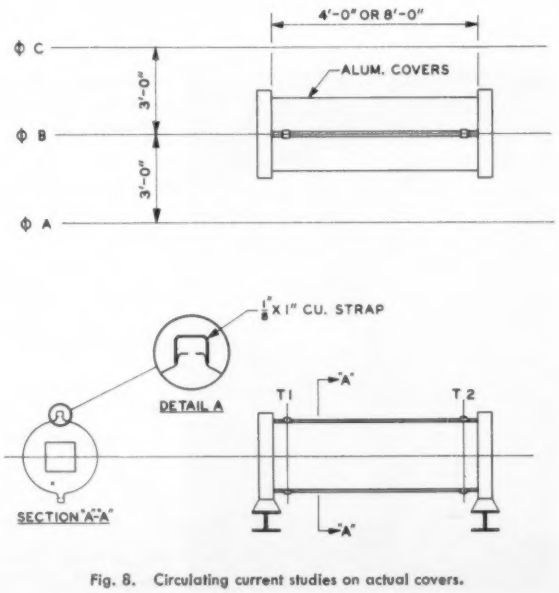

Fig. 8. Circulating current studies on actual covers.

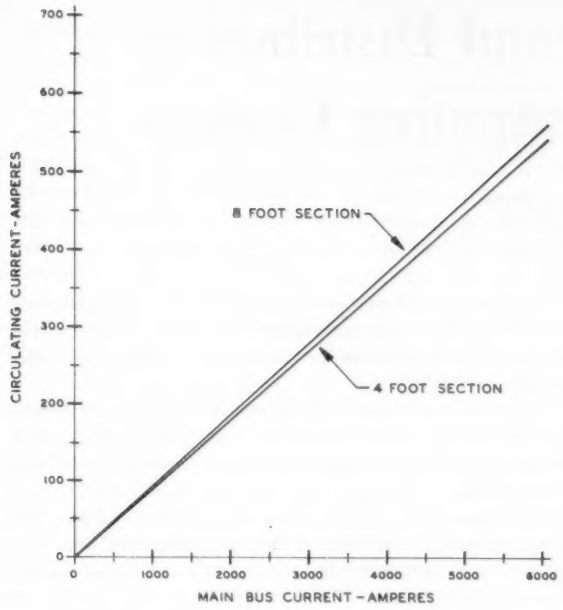

Fig. 9. Cover circulating current vs current in mains.

4 inches, 8 feet 10 inches, and 17 feet 0 inches in length. Maximum temperature rises occurred in the ends of the duct sections where each section was insulated from the adjacent sections. Proximity effect tends to increase temperature readings by drawing all the current through the very edges of these sections.[1] Variations of only 3-C rise were found on all the aforementioned lengths.

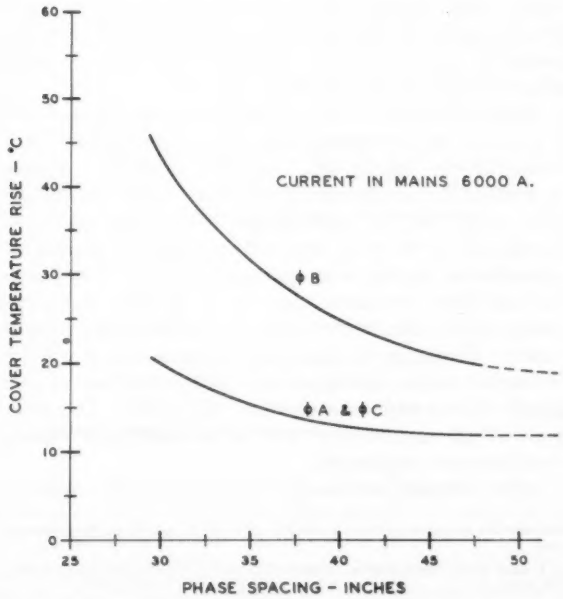

Fig. 10. Cover temperature rise vs phase spacing.

COVER HEATING VS PHASE SPACING

With the new telescoping bus, longitudinal cover bolts are no longer a necessity. Since additional room is not required between phases to install cover bolts, this feature lends itself to the design of bus ducts at closer phase spacings. Tests were made to study the effect phase spacing might have on cover heating. A 25-foot-long 6,000-ampere 3-phase bus run setup was used. Heat runs were made at the following phase spacings: 29 (minimum possible), 32, 36, 40, 44, and 48 inches. Fig. 10 shows maximum cover temperature rise plotted against phase spacing.

The maximum rise occurs at the smallest phase spacing, where the combined effect of the fluxes from the three phases are the greatest. A somewhat rapid nonlinear decay of the cover rise results during the next 10 inches of increased phase spacing. For the second 10 inches of increased phase spacing the rise continues to decay, but at a slower rate, whereupon the curve approaches a zero slope. Here, the cover temperature rises are at their minimum because the covers of each phase are influenced only by their own field and the contribution of fluxes from the other two phases becomes inconsequential.

From the results attained, it can be deduced that wherever possible, the maximum feasible phase spacing should be used when heating in the covers is to be held to a minimum.

MISCELLANEOUS

The various size busses have been thoroughly checked for current-carrying ability. Complete flashover and withstand tests have been made on straight sections, elbows, bushings, wall baffles, etc. In some designs, grading shields have been used at corners and over flexible to improve flashover and withstand values.

A variety of tightness tests have been made on the enclosures in the laboratory, all showing very small leakage. In one test where four telescopic sections were involved, a pressure of 28 inches of water (approximately 1.0 pounds per square inch) was applied, and after a period of 40 hours only 5 inches of water had been lost. This guarantees a bus of unusual tightness and one which should be as waterproof as it is possible for a gasketed bus to be.

CONCLUSIONS

1. A bus has been designed which can be installed easily and inspected conveniently.
2. A bus of exceptional tightness has been designed which uses a minimum of gaskets and eliminates gasket bolts.
3. Currents induced in the covers vary directly as the current in the mains.
4. Beyond a length of a few feet, cover heating is practically independent of length.
5. At normal phase spacings, cover heating varies inversely as the distance between phases.

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Power Generation and Distribution at Air Defense Computing Centers

J. J. GANO
MEMBER AIEE

Uninterrupted power for electronic computers at weapons direction centers, as provided by this diesel-power generation and distribution system, has been a primary design objective. By installing reserve generating capacity, duplexing the power-distribution system, and emphasizing equipment reliability, continuity is achieved.

THE HEART of the SAGE (Semi-Automatic Ground Environment) system for the air defense of the United States consists of a large number of weapons direction centers, which house high-speed electronic digital computers for the continuous processing of large amounts of data funneled into the centers. The processed information is displayed to military personnel on cathode-ray tubes, enabling them to analyze the air situation and to direct action against enemy air attack. Each direction center is equipped with two computers, both of which are energized, but one is active and the other is on stand-by status prepared to take over defense calculations at a moment's notice. By pursuing an extensive program designed to obtain high reliability, each computer is expected to be in good operating condition close to 100 per cent of the time. Continuity of electric power is one of the factors affecting this reliability. Even when a computer is malfunctioning, power should be provided in order that a diagnosis can be quickly made and the trouble promptly repaired. Furthermore, because computers operate in the time region of microseconds, power interruptions even of short duration are undesirable. The power generation and distribution systems for these direction centers have been designed with continuity of power as the objective. Outage time is expected to be mainly a result of human error in operation.

LOAD AND PERFORMANCE REQUIREMENTS

IN PLANNING for some growth in electronic equipment, the peak demand to be satisfied has been established at 2,600 kw. The load breakdown including allowances for growth is as follows:

Item	Power, Kw
Electronic equipment	860
Motor-generator losses	170
Telephone equipment	100
Electronic-maintenance equipment	40
Equipment-cooling (fans and pumps)	180
Lighting	300
Refrigeration	500
Power house auxiliaries	450
Total	2,600

During the first year of operation, the summer peak load will be 2,000 kw and the winter peak load 1,700 kw. The occasional shutdown of a computer will reduce the load another 400 kw.

Inasmuch as all power going to critical computer sections passes through power-conversion equipment voltage regulators, the voltage at the generator bus need not be held very closely. Although ±5 per cent is satisfactory, the voltage most likely will be maintained within ±2 per cent. The frequency tolerance is also a liberal ±2 per cent, because the computers rely on crystal-controlled oscillators for timing pulses. The magnetic-memory drums are the only frequency-critical equipment and the system is designed to allow a 2-per-cent variation in the speed of the synchronous motors which drive them.

GENERATING SYSTEM

THE ARRANGEMENT of the diesel generators on the two main busses, which are normally connected by a circuit breaker, are shown in Fig. 1. The split bus assures sufficient power to operate at least one computer from one bus, even if a main-bus fault should occur. Six identical 650-kw units, giving a total installed capacity of 3,900 kw, result in an economical plant having considerable flexibility for the wide range of loads, varying from the low of the first-year winter load to peak demand after growth. Even when generating for the first-year winter load of 1,700 kw, the connected engines will be operating in a region of high efficiency and low maintenance.

Published figures[1] of 10 per cent for planned outage and 1 per cent for unexpected outage for diesel engines were conservatively determined. Application of these figures in probability calculations results in a total power outage of a theoretical few minutes per year. The ability to transfer two of the diesel generators to either bus permits an arrangement of generators, so that each of the two busses has sufficient connected capacity to operate one computer, even when two engines are undergoing maintenance. During initial operation, an extra diesel will be connected to the busses, so that unexpected loss of one diesel will not produce a deficiency in power. This principle of "spinning reserve" will be continued until experience proves it unnecessary.

Before selecting diesel engines as the prime power source, a

Full text of a special article recommended by the AIEE Committee on Power Generation.

J. J. Gano is with Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.

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thorough investigation of other possible sources was made. Commercial power with diesel stand-by was eliminated because of the relative unreliability of transmission lines to many of these centers. Should a sudden power failure occur, it may be possible to start the diesel plant within 1 minute, but even such a brief interruption is undesirable for an effective air defense system. It was further suggested that the most reliable stand-by diesel plant is an operating one. Gas turbines were eliminated because of insufficient operational data on reliability and maintenance. Although there are a large number of gas turbines in the field, there was little information on operation available, particularly in the size range of interest. Steam-turbine plants were carefully analyzed. The reliability of the combined turbines and boilers was concluded to be comparable to that of diesel engines and an economical steam plant would have required the complexity of extraction or mixed pressure turbines, which are not common in the small sizes.

A generator voltage of 480 was selected for reasons of economy and simplicity. Because all power is consumed in the powerhouse or in the direction center, which have a common wall, the transmission losses are low.

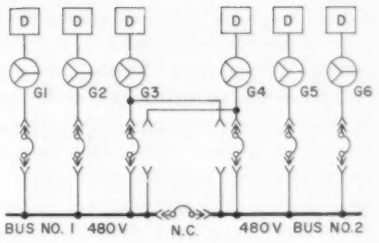

Fig. 1. Arrangement of diesel generators, each rated 650 kw, 0.8 power factor.

DISTRIBUTION SYSTEM—GENERAL

A SIMPLIFIED single-line diagram of the distribution system is shown in Fig. 2. The system is duplexed, so that failure of any individual feeder or distribution equipment will, at worst, cause a power shutdown of only one computer.

The critical electronic load of the computers is delivered through motor-generator sets. A small amount of computer load that is less susceptible to voltage variations is supplied by 750-kva transformers, operating from the generator busses. This source of 208/120 volts also provides power to telephone equipment, electronic maintenance equipment, and lighting. Most of the power for telephone equipment is consumed by transmitters and receivers for digital data to and from radar sites. The only other loads in the direction center building are the motors for driving pumps and fans to maintain the electronic equipment at operating temperatures compatible with desired reliability. The magnitude of these various loads is indicated in the diagram.

Distribution panels in the powerhouse supply the auxil-

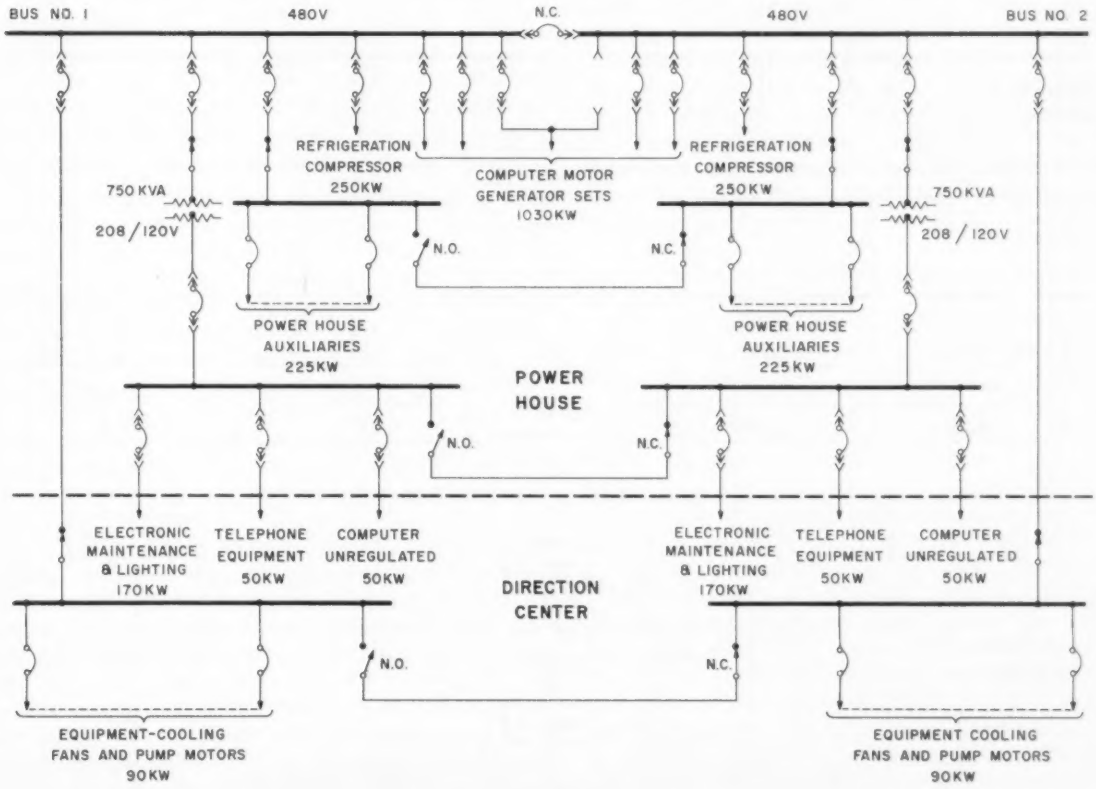

Fig. 2. Power distribution, general.

iaries for power generation and refrigeration. Wound-rotor induction motors which drive the refrigeration compressors are connected directly to the generator busses.

Corresponding panels in both the powerhouse and direction center are provided with connecting lines and disconnects at both ends. One each of the disconnects is normally closed and the other open. Appropriate interlocks prevent the simultaneous feeding of power to the same panel from both generator busses. Feeders to the panels have a capacity sufficient to carry the load of both sides. The connecting line to the 208/120-volt panels automatically closes upon loss of voltage to either side after a brief time delay. Thus, both computers should continue to operate without interruption. The line which connects equipment-cooling panels must be closed manually upon failure of a feeder. This may or may not result in a computer shutdown. It has been estimated that the computer can operate a few minutes without cooling. To prevent permanent damage to the computer, it is automatically turned off within this period if the cooling air should fail. If the trouble is obvious and the disconnect can be closed without jeopardizing the operation of other equipment, the computer will continue to operate. If closure appears risky, air defense calculations can be transferred to the stand-by computer in an orderly manner.

Similarly, there is an appreciable time lag before the failure of power to the powerhouse auxiliaries becomes sufficiently critical to warrant shutdown of the diesel engines, if a manual closure of the connecting lines to the panels has not been effected. The only critical loads on these panels are the jacket-water pumps for the diesel engines. Should experience indicate that the time between power failure and engine heating is short, an automatic transfer switch will be installed for the pumps. Thus, the generating capacity will be maintained.

ELECTRONIC LOAD DISTRIBUTION

The distribution system for the electronic equipment is designed to minimize power switching and to isolate equipment that is performing air defense calculations from equipment that is on stand-by status or undergoing repair. As shown in Fig. 3, the computer power-conversion and power-distribution system is duplexed in a manner similar to that of the generating and general power-distribution system. The electronic load passes through four motor-generator sets. Two of the motor-generator sets, one on each bus, supply identical central computers. Input-output equipment, which is the communicating link between the bases and centers outside the site and the display equipment which gives a visual presentation of the air situation to those engaged in military operations within the building, are separated from the central computer distribution system.

Each of the identical motor-generator sets contains three units that include a 400-hp induction motor and two 60-cps generators, one having a 200-kw rating and the

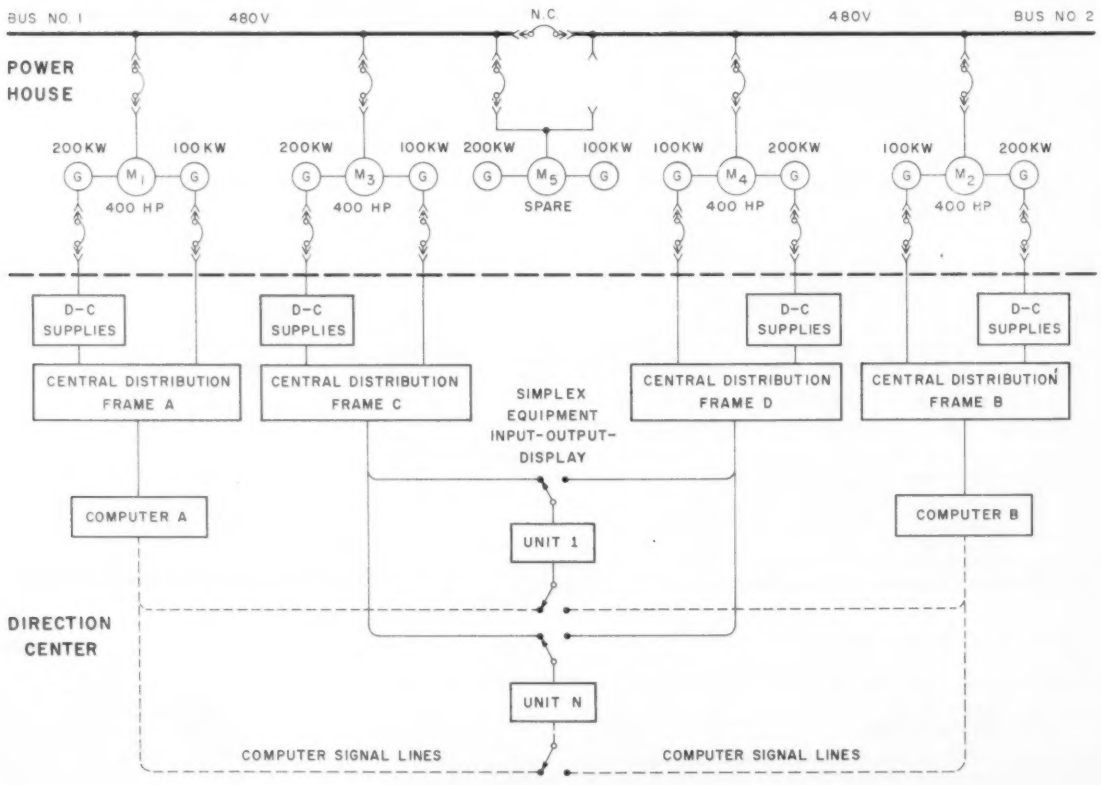

Fig. 3. Computer power distribution.

other a 100-kw. The output voltage is 208/120. The smaller generators provide filament power for the electronic tubes with a small amount going to high-voltage d-c supplies in the display equipment. The larger generators feed sets of d-c supplies containing 11 voltage units. These supplies, which are well regulated for both steady-state and transient disturbances, employ selenium rectifiers and magnetic amplifiers, but no electronic tubes. The filament power and the d-c voltages are connected to central distribution frames. The details of the distribution to the electronic frames are not shown.

The motor–generator sets are installed between the generator busses and the electronic equipment for the following reasons:

1. *Voltage Regulation.* The voltage at the output of these generators can be held more closely than that on the generator busses. By maintaining the voltage at the filament heaters of the electronic tubes within ±2 per cent, tube life is extended. Also, because transients on the generator bus are filtered by the sets, the d-c supplies are not required to operate over as wide a range of supply voltages, thus simplifying their design and reducing their cost.

2. *Filament Cycling.* The generator regulator is utilized to increase the filament-heater voltage linearly from zero to full voltage in 1 minute and the reverse for voltage removal. This procedure eliminates the application of thermal transients to the heaters and thus reduces to negligible levels tube failures due to open heaters or cathode-to-heater shorts.

3. *Transient Filtering.* The rotating machines acting as energy storage elements prevent severe fault transients from entering the system and causing errors. They also serve to decouple voltage transients, caused by switching of loads in any of the other distribution systems.

A spare motor-generator set can be connected to either generator bus, and its outputs (not shown) can be connected to any of the loads of the other four sets. In this way, only brief shutdowns for substitution at opportune moments are necessary to conduct routine maintenance. Separate generators for the d-c supplies and filament heaters are employed in order to maintain close regulation for the heaters. The amount of distortion caused by the d-c rectifiers on the generator output waveform is a function of the load, and since the generator regulators sense the rectified output, the rms voltage, which should be closely held for long tube life, may not be sufficiently regulated.

The input, output, and display equipment is not duplexed, because of the nature of this type of equipment. Whereas the failure of a single component in the computer reduces its operational efficiency appreciably, if not completely, a failure in the input, output, and display devices results in the breakdown of one of a multiplicity of units and has a negligible effect on the over-all efficiency of the air defense system. Furthermore, for each type of device there is a spare which can be quickly substituted for the faulty unit. This input, output, and display equipment is referred to as "simplexed." The power-conversion and

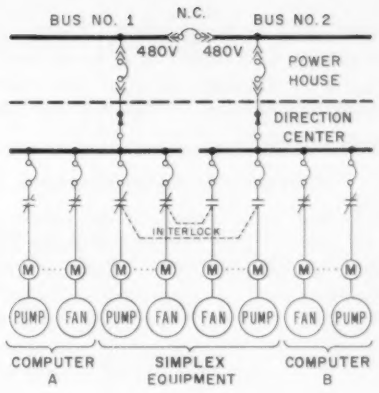

Fig. 4. Power distribution to cooling-equipment motors.

distribution system for it is not only electrically separated from the central computers, but it is also duplexed, with both sides being energized at all times. The computer which is performing air defense calculations, the simplex equipment communicating with it, and the power-conversion and distribution system supplying this simplex equipment are all referred to as active. The counterparts are referred to as stand-by. The active simplex equipment and the active computer do not necessarily receive their power from the same generator bus.

Faulty simplex units are transferred to the stand-by power system for repairs. Inasmuch as the simplex equipment is more susceptible to troubles than the central computers, power to sections of it will be switched relatively frequently. The transients generated by this procedure may cause inconsequential flickers in the oscilloscope displays, which should not be annoying so long as they do not occur every few minutes. The isolation of the computers from the simplex equipment also eliminates the possibility of these transients causing computer errors. If a failure in the power-conversion and distribution equipment occurs, the manual operation of a single switch will energize relays to transfer all the simplex equipment to its stand-by power system, and the simplex equipment undergoing test or repair will be disconnected.

In normal operation all four of the power-conversion and distribution systems are energized. The breaker between the two generator busses is closed, in order to have sufficient connected capacity on these busses to prevent a voltage decrease that would drop fluorescent lights upon starting of a large motor, even with reduced-voltage starters. Should a generator bus fault occur, the normally closed breaker between the two busses opens within six cycles. Because of the energy storage int he motor–generator sets and the regulating ability of the d-c supplies, the computer in the nonfaulted bus will operate without error. Thus, upon the occurrence of such a fault, it is seen that, at most, the only power switching required is in the simplex system. Power switching has been minimized in the design because experience has indicated that most troubles occur when power is switched. Failure of a single simplex unit caused by power switching is not serious. Whenever air defense calculations are transferred from one computer to the other, only signal lines from the computers to the simplex

units have to be switched. Failure to complete signal switching to a single unit is similarly not serious. As previously discussed, faults at other points of the nonelectronic distribution system will not cause sudden computer shutdown.

DISTRIBUTION FOR COOLING EQUIPMENT

POWER DISTRIBUTION to the motors, which drive fans and pumps in the cooling system for the electronic equipment, is shown in Fig. 4. Fans and pumps supplying the cooling for the computers are connected to the corresponding generator bus. A failure occurring in the system supplying the active computer will necessitate a transfer of the air defense calculations to the stand-by computer. The cooling system for the simplex units is designed with the same philosophy as the power-conversion and distribution system. Duplicate motors are connected to each of the generator busses. Should air flow stop for any reason, the stand-by motor is automatically energized after a few seconds' delay. The delay is brief because of the concentrated heat loads in the simplex units. Only that portion of the duct work and piping which contains the fans and pumps is duplicated.

CONCLUSION

BY EMPLOYING six 650-kw diesel-generator units to meet a peak load of 2,600 kw, a power plant has been planned that is economical and yet has a flexibility which can accommodate varying loads and provide for growth. The installation of reserve generating capacity, the duplexing of the entire power distribution system, and the special emphasis placed on the reliability of all equipment and its installation should result in a power generation and distribution system providing uninterrupted power to at least one of the two identical computers engaged in air defense calculations. The symmetry of electrical design is extended to the physical arrangement of equipment to facilitate trouble-shooting and maintenance, and diesel engine and refrigeration auxiliaries have been designed with the same objective of high reliability.

ACKNOWLEDGMENT

THE INVESTIGATIONS on power generation and general power distribution were conducted by Burns and Roe, Inc., consultants for the Western Electric Company, responsible for the construction of the sites and the installation of the equipment; and by Jackson and Moreland, Inc., consultants for Lincoln Laboratory. Francis Associates designed the distribution for the cooling equipment. International Business Machines Corporation, as prime contractor for the electronic equipment, participated in the development of the distribution system for this equipment.

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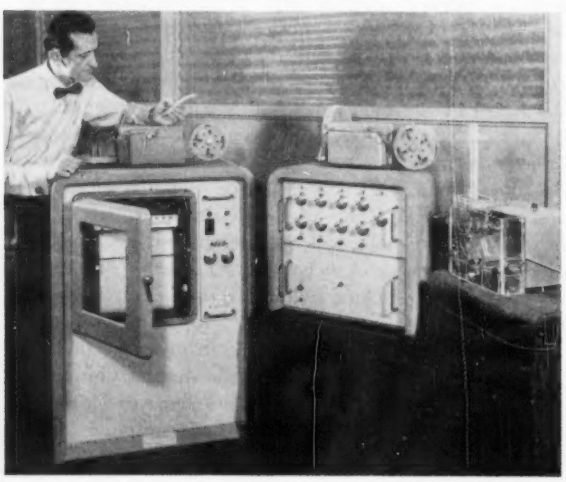
Automatic Testing System for Electronic Components

Completion of an integrated automatic test and inspection system for the evaluation of a wide variety of electronic components and other products has been announced by Electronic Control Systems, Inc., of Los Angeles, Calif., an affiliate of Stromberg-Carlson, and a subsidiary of General Dynamics Corporation.

This new system automatically transports, tests, and physically sorts for quality components such as semiconductor diodes, and keeps records on punched paper tape. In addition, it automatically assembles over-all quality statistics.



The complete system consists of five basic elements: automatic hopper feed mechanism; automatic sorter; automatic tester and recorder; automatic analyzer; and a keyboard input to the automatic analyzer. At the right is the automatic feed and sorting mechanism; the unit at the center is the testing and recording element; at the left is the statistical analyzer.

For application to electronic components, a hopper has been designed for the automatic feed mechanism, to permit bulk loading of axial lead components. Such components are automatically oriented and loaded into the tester, where they are evaluated and sorted into quality classes on the basis of one or more parameters.

The system automatically tests and records two samples per second, with an accuracy of better than 0.5 per cent. A paper-tape punch records the test results. From the paper tape, the analyzer automatically plots a 16-interval frequency histogram showing the distribution of the tested parts. The analyzer can be equipped to compute automatically the range, average, and standard deviation of the tested parts.

The advances of automation in testing appear to be particularly valuable in the manufacture of semiconductors and other electronic components where it is predicted that substantially improved quality control will be possible through the rapid availability of data.

Variably Damped Servomechanisms

L. SCHIEBER
ASSOCIATE MEMBER AIEE

VARIABLE DAMPING allows more efficient use of the inherent capabilities of the components making up a servomechanism. It becomes possible to obtain a considerable improvement over the dynamic performance of a linear servomechanism using the same components. It permits the designer to use lower amplifier gains and smaller servo motors, thereby saving space, weight, and electrical power. The stability of the servomechanism can be made less dependent on backlash because a lower gain error transducer can be used. The variation of the characteristics with amplifier gain is also quite small. The servomechanism will follow high velocity inputs almost as accurately as it follows low velocity inputs, and in addition, "ideal" transient response is possible with no overshoot and low settling time.

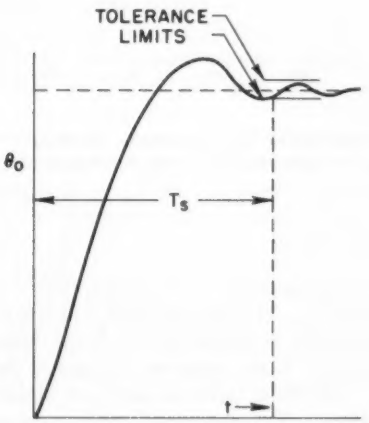


Fig. 1. Settling time of a typical underdamped servomechanism.

A linear servomechanism will follow an input which is changing at a constant rate with a constant error. The magnitude of the error is directly proportional to the input rate. When very high rates are put into the servomechanism, it becomes difficult to reduce this error to an acceptable value. The usual method for reducing the following error is to design the servomechanism with a very high open-loop gain. This type of servomechanism is susceptible to amplifier noise and saturation effects as well as instability due to backlash and wire hopping.

A variable damped servomechanism circumvents these difficulties by making the open-loop gain proportional to the following error existing at any time. In this manner, the following error can be made almost completely independent of the input rate. Breadboard results show that the following error may be decreased by a factor of 12 through the use of variable damping.

Another criterion for measuring the performance of a servomechanism is the length of time between a sudden displacement of the input and the time at which the output again corresponds to the input. This time is called the "settling time" (Fig. 1.) It is, once again, dependent upon the open loop gain of the servomechanism. It is, of course, desirable to minimize the settling time. In order to do this, the servomechanism should approach the new value of the input as rapidly as possible and, upon reaching this new value, remain there. These two conditions are contradictory in a linear servomechanism; the first requires a small amount of damping, the second requires a large amount of damping. However, the damping in a variably damped type of servomechanism is an inverse function of the error; therefore, both conditions can be met by this type.

Fig. 2 shows in block diagram form the essential elements of a simple variably damped servomechanism. Its open loop transfer function is

$$\frac{\theta_0}{E}=\frac{K_eK_aK_m}{g[1+K_aK_mf(E)]}\left[\frac{1}{s\left(s\dfrac{T_m}{1+K_aK_mf(E)}+1\right)}\right]$$

From this expression the velocity error constant K_v and dimensionless damping ratio ζ may be written as

$$K_v=\frac{K_eK_aK_m}{g[1+K_aK_mf(E)]}$$

$$\zeta=\sqrt{\frac{g[1+K_aK_mf(E)]^2}{4K_eK_aK_mT_m}}$$

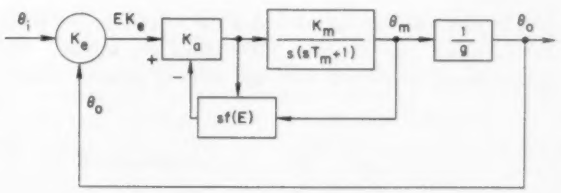


Fig. 2. Block diagram of a variably damped servomechanism.

Using these equations, the designer may select a damping ratio at zero error and a velocity error constant for the maximum velocity input to suit his needs. The foregoing equations may be written explicitly in terms of the input velocity or the error—whichever is most convenient.

Digest of paper 56-958, recommended by the AIEE Committee on Feedback Control Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1–5, 1956. Scheduled for publication in AIEE *Applications and Industry*, 1956.

L. Schieber is with the International Business Machines Corporation, Endicott, N. Y.

Epoxy Resin Casting of Dry-Type High-Voltage Components

C. W. PARK
ASSOCIATE MEMBER AIEE

Epoxy resin casting provides an effective means for embedding such high-voltage electrical components as transformers, bushings, and pot-heads. The molding process and the techniques which have been used in determining optimum shapes are described.

EPOXY RESINS have been used in the indoor components to be described for several reasons. First in importance is the elimination of any air inclusions, which if present would lead to destructive corona. Second, the physical size of the units has been greatly reduced in proportion to their voltage-handling capabilities. The third reason is that the necessity for an insulating oil has been eliminated.

It will be noted that the height-to-diameter ratio of these epoxy units has been kept near unity. This has been impractical with ceramics, because of the limitation that thick sections cannot be cast in one piece.

In all epoxy units a buried ground electrode has been used to control the distribution of the surface gradient. (The epoxies have excellent properties of adhesion to metals.) The buried ground electrode cannot be incorporated in ceramic castings, because of high firing temperatures.

The designs described have been accomplished through use of field-plotting boards to ascertain the correct flux distributions.

The field-plotting board makes use of conducting paper with a resistance of about 5,000 ohms per square. The entire board is covered with one sheet of paper, which in the portions representing the air dielectric is equivalent to a dielectric constant of unity. The epoxy portion, which may be to some convenient scale, is represented by several thicknesses of the same paper. If the dielectric constant of the epoxy is 6, then five additional layers of paper are tacked down on the large sheet. A cross-sectional representation of the metallic portions of the assembly is painted on the conducting paper with a conducting silver paint. This paint has a resistivity of less than 3 ohms per square, and this can be made still less by the application of several coats. A potential of 3 volts, 60 cycles is applied between the simulated high-voltage and ground electrodes with a precision potentiometer in parallel. A vacuum-tube voltmeter is connected between the swinger of the potentiometer and a probe that is placed in contact with the conducting paper. The potentiometer is set to some ratio and the probe is moved around over the paper to find the null point. With this method, equipotential lines are plotted, usually in 10-per-cent steps. The epoxy and metallic dimensions are adjusted to give a uniform gradient along the surface where

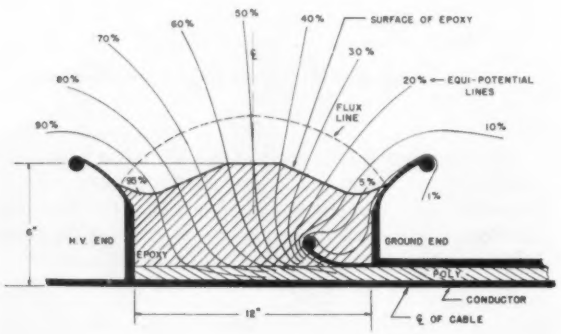


Fig. 1. Illustrating use of a field-plotting board for determining optimum shape of epoxy portion of cable pothead shown in Fig. 5.

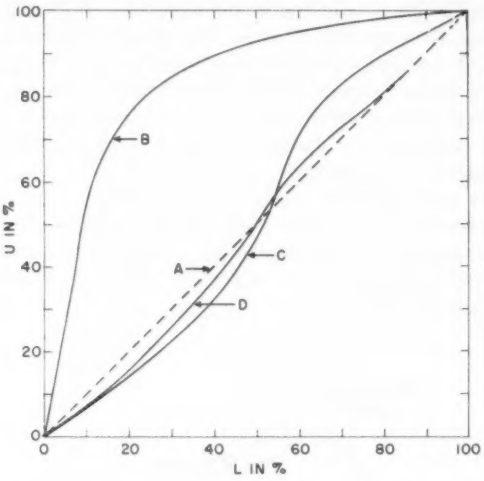


Fig. 2. Gradient distributions for various components. (A) shows the desirably uniform gradient; (B) indicates that the component should be reshaped.

A special article recommended for publication by the AIEE Committee on Dielectrics.

C. W. Park is with the University of California Radiation Laboratory, Berkeley, Calif.

The work described has been performed under the auspices of the United States Atomic Energy Commission.

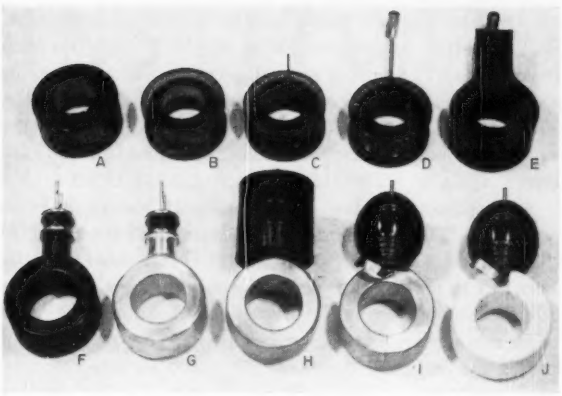


Fig. 3. Stages in fabrication of filament transformer secondary winding, designed for high-voltage operation.

the epoxy will be in contact with the air. Fig. 1 shows an example of the use of a field-plotting board. Fig. 2(A) shows the desired gradient distribution.

When the desired shape has been determined and a mold has been prepared, the epoxy is mixed with hardener and filler and is vacuum pumped before it is poured into the mold. After it is poured into the mold, the mix is again vacuum pumped to remove all included air and moisture. The mold is coated with a release agent, which also imparts a high-gloss finish to the epoxy.

The earlier epoxy units used no filling material, and were of an amber color with some transparency. This transparency was helpful in locating flaws or cracks. The material used at present has an added filler of glass beads 20 to 70 microns in size, and is opaque. It has a dielectric constant of 6, whereas the unfilled type had a dielectric constant of 4.

Fig. 3 shows the various fabrication stages of a secondary coil for a filament transformer to be operated at high voltage. The diameter of the inner hole is 3 inches and is ample for the primary coil and core. The secondary coil consists of 10 turns of number 10 B and S enamel wire and is rated at 5 volts, 30 amperes, 60 cycles. The surface of the epoxy surrounding the coil is painted with a conducting silver paint, which has good adherence and leaves no air voids. The silver is copper plated to give mechanical protection and to lower the resistance. This copper-plated shield is connected to ground, and being a short-circuited turn, is slit as shown in Fig. 3(I). In the pilot model, the coil leads were brought out through a simple neck 3.5 inches long, similar to Fig. 3(E).

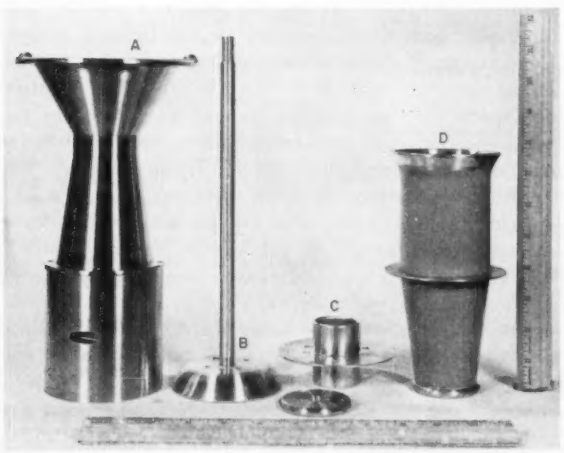


Fig. 4. Mold, metal parts, and a finished bushing made in one pour of epoxy resin.

Fig. 5. Completed bushing for cable pothead.

This unit was tested at 100 kilovolts d-c with no breakdown, but displayed surface corona streamers at 18 kilovolts rms, 60 cycles. The neck was lengthened to 5 inches with little improvement. A plot of the surface gradient for this simple neck is shown in Fig. 2(B). This curve shows that 55 per cent of the surface gradient occurs on the first 10 per cent of the length and that the upper half has only 7 per cent of the total gradient. This latter condition indicates that there is almost no potential difference along this surface and that the neck could be shortened with little difference in the final result. The neck was turned down and two metal rings were installed as shown in Fig. 3(F). The upper ring is connected to one coil lead, and the lower ring is extended downward to the grounded metal. These two rings were then imbedded as shown and the casting was turned into a spherical shape. The unit was tested and flashover occurred at 100 kilovolts rms, 60 cycles. Flashover occurs along and close to the curved surface, sometimes marking up the Epon surface. A plot of the surface gradient is shown in Fig. 2(C).

In later designs described in this article the epoxy surface does not follow along a sparkover flux line. This secondary winding was tested at normal current, with 60 kilovolts rms, 60 cycles between the winding and ground

for a period of 110 hours with no ill effects. Other secondary coils of the same physical size have been made with a 5-volt 70-ampere rating and a 115-volt 4.5-ampere rating. These units have the primary winding on another leg of the core. The 115-volt winding was enclosed in an inner electrostatic shield which was brought out coaxially around the coil leads.

Another approach to the high-voltage, dry-type transformer is made through the use of a mica-insulated, vacuum-impregnated transformer, potted in asphalt or oil, with the high-voltage leads brought through the tank cover by means of an epoxy bushing. The development of this bushing started by suspending a metal "hat" as shown in Fig. 4(B), 3 inches above a ground plate. Various configurations were tried until one was found that just sparked over at 100 kilovolts rms, 60 cycles. This shape was then put on the plotting board and the epoxy size as well as the placement of the buried ground shield adjusted until a good surface-gradient distribution was obtained. The final curve is shown in Fig. 2(D). Fig. 4 shows the mold, metal parts, and a finished bushing. This bushing flashes over at 100 kilovolts rms, 60 cycles, and along a flux line which is about 3/4 inch from the epoxy surface at the 50-per-cent point. These bushings are made in one pour in the inverted position. The overpour is removed by means of a lathe and the lower metal ring is swaged on the central metal tube. Transformer leads are carried through the metal tube, with a metallic connection at the top between the "hat" and one of the coil leads. This design has been used also on units rated 62, 75, and 150 kilovolts rms, 60 cycles.

Coaxial cables of the X-ray and *RG* types are capable of withstanding high voltages, but the termination is always the weak place. The buried ground shield technique has been used by piling up a tape ball, carrying the shield out on the ball by means of foil, and then piling on more tape. An epoxy-type termination for an *RG 19/U* cable has been developed. The unit is slipped over the end of the cable and the shield is carried off on the tapered extension. A Zerk fitting is provided, and silicone grease is forced into the small void between the cable and the epoxy and ground support.

A completed 500-kilovolt cable pothead bushing is shown in Fig. 5. The unit, made in five pours, has a center epoxy diameter of 12 inches. The center metal mold rod has been left in for handling and shipping purposes. No voltage breakdown test has been made on this pothead. Two of these units are now being installed. The plot for this unit is shown in Fig. 1.

CONCLUSION

THE EPOXY UNITS that have been described have been used on electric equipment to supply power to particle accelerators. Some of the applications appear at first to be of a d-c nature but, because of the sparking nature of the accelerator loads, require an a-c design. Other units which appear at first to be in d-c application, such as voltage-doubler filament transformers, have to be designed for a-c service.

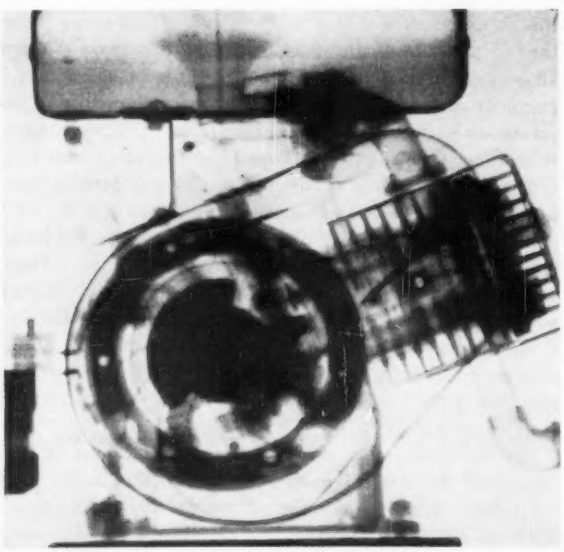
Plotting on the plane surface of the field-plotting board appears to be inexact, but the results obtained indicate that this method is sufficiently accurate for the purpose.

REFERENCES

1. Epoxy Resin Casting of Dry Type Current Transformers, **W. C. Farneth, George Gallousis.** AIEE *Transactions*, vol. 74, pt. III, Apr. 1955, pp. 194–97.

2. Theory of Dielectrics (book), **Schwaiger, Sorensen.** John Wiley and Sons, New York, N. Y., 1932.

Stroboscopic X-Ray Technique Developed



The inner secrets of a running engine have been exposed in this pioneer X-ray picture, the result of a new stroboradiographic technique developed by the General Electric Company in co-operation with the Detroit (Mich.) Arsenal. Using radiation pulses of a 5- to 15-million-volt betatron and special strobographic equipment, engineers now can get slow-motion and stop-motion photographs through the engine block and cylinder walls of a running engine. The X-ray photograph shown at the right was taken of a 2-hp 4-cycle gasoline engine with equipment designed for a special research project at the Arsenal, and developed at the General Electric Company's General Engineering Laboratory at Schenectady, N. Y.

The "stop" action in the X-ray photograph was obtained by superimposing several thousand short exposures synchronized with the pulses in the engine cycle. The new process could prove to be a boon to design engineers who now will be able to observe for the first time possible flaws or inefficiency of moving parts of engines or other equipment running at high speeds under load conditions.

INSTITUTE ACTIVITIES

49 Technical Committees Plan for 101 Winter General Meeting Sessions

THIS YEAR the Sheraton-McAlpin Hotel, as well as the Hotel Statler, will be used for technical sessions and committee meetings in connection with the AIEE Winter General Meeting, January 21-25, 1957.

At this time, 49 technical committees in the 6 divisions have announced plans for 101 technical sessions. In the Power Division, the Rotating Machinery and Transmission and Distribution Committees have scheduled six sessions each. In addition, there will be four sessions each sponsored by the Switchgear and Transformer Committees. The System Engineering, Carrier Current, Insulated Conductors, Protective Devices, Power Generation, Substations, and Relays Committees are also arranging for one or more sessions.

Committees in the Communication Division have announced a joint session on the Transatlantic Telephone Cable as well as technical sessions on Communication Theory, Television and Aural Broadcasting Systems, Radio Communications Systems, Communication Switching Systems, Wire Communications Systems, and Telegraph Systems.

In the Industry Division, technical meetings on Industrial Power Systems, Industrial Power Rectifiers, Petroleum Industry, Industrial Control, Feedback Control Systems, and Mining and Metal Industry are being organized.

The committees in the Science and Electronics Division are also organizing sessions on Magnetics, Nucleonics, Electrostatic Processes, Polyethylene, Basic Sciences, Electronic Reliability, Electronic Circuits, Dielectrics, Magnetic Amplifiers, Electron Tubes, Dielectric Devices, Computing Devices, and Electrical Techniques in Medicine and Biology.

Other sessions, announced by committees in the Applications Division, are on Land Transportation, Domestic and Commercial Applications, and Production and Application of Light. In the new Instrumentation Division, sessions are being planned on Special Instruments and Auxiliary Apparatus, Indicating and Integrating Instruments, Recording and Controlling Instruments, and Satellite Telemetering.

Among the general committees of the Institute, sessions are being organized on Ethics, Management, Safety, Education, and Research.

Informal Tea

This social gathering before the formal program begins has been enjoyed by more and more people each year. Make it a point to attend this year—Sunday afternoon, January 20, from 4 to 6 p.m., in the Georgian Room of the Statler. There will be no charge.

During this period the registration facilities will be open for those wishing to avoid the Monday morning rush.

Hotel Reservations

The general headquarters will be at the Hotel Statler but a number of the technical sessions and committee meetings will be held at the Sheraton-McAlpin. Modernization of both meeting rooms and guest rooms is under way at the Sheraton-McAlpin, which is just a block away from the Statler, and the Committee is confident that the accommodations will be satisfactory.

Blocks of rooms have been set aside for AIEE at the following hotels covering both the Pennsylvania and Grand Central areas, and rates are listed for guidance in requesting reservations.

Hotel Statler (meeting headquarters), 7th Ave., 32nd to 33rd St.

Single Room	$ 8.00 to $12.00
Double Room	11.00 to 16.00
Twin Bedroom	11.50 to 19.00
Suites	30.00 and up

Hotel Sheraton-McAlpin (also used for meetings) Broadway, 33rd to 34th St.

Single Room	$ 6.85 to $11.25
Double Room	10.35 to 14.75
Twin Bedroom	12.50 to 17.75
Suites	22.00 to 32.00

Hotel New Yorker, 8th Ave. and 34th St.

Single Room	$ 7.00 to $10.00
Double Room	10.00 to 14.00
Twin Bedroom	12.00 to 17.00

Hotel Martinique, Broadway at 32nd St.

Single Room	$ 6.00 to $11.00
Double Room	9.00 to 14.00
Twin Bedroom	9.00 to 16.00

Hotel Commodore, Lexington Ave. and 42nd St.

Single Room	$ 9.00 to $12.00
Double Room	12.50 to 15.50
Twin Bedroom	13.00 to 17.50

Hotel Roosevelt, Madison Ave. and 45th St.

Single Room	$ 8.50 to $13.50
Double Room	14.00 to 17.50
Twin Bedroom	16.50 to 20.00

All rates quoted are subject to a 5 per cent New York City occupancy tax.

SPECIAL NOTE: Because the time of the AIEE meeting conflicts with two other large groups in 1957, the hotels will be more crowded than in recent years. *None of the hotels will guarantee any rooms not reserved prior to January 7, 1957.* The Committee suggests that where possible, doubling up with a friend will not only save money but will ease the hotel situation; also that reservations be made for the entire week beginning Sunday, January 20.

Please send requests for reservations directly to the hotel, specifically referring therein to the AIEE meeting. Do not write to more than one hotel. If requests cannot be filled, the hotel will automatically refer the request to the Hotel Reservations Committee, which will endeavor to obtain a similar reservation at another of the Convention hotels.

Theater Tickets

As in the past, tickets to the following shows currently playing in New York will be available to AIEE members during the week of the meeting. All prices shown are brokers' prices.

	Evenings		Matinees
	M, T, W, T	F, S	W
Damn Yankees Gwen Verdon	$8.60	$8.60	$5.15
Inherit the Wind Paul Muni	5.70	6.85	5.15
Middle of the Night Edward G. Robinson	6.85	6.85	5.15
New Faces of '56	8.00	8.60	5.70
No Time for Sergeants	5.70	6.85	5.20
Mr. Wonderful Sammy Davis, Jr.	8.00	8.60	5.70
The Diary of Anne Frank Susan Strasberg Joseph Schildkraut	6.85	6.85	4.55
The Loud Red Patrick Arthur Kennedy David Wayne	6.85	6.85	5.15
The Most Happy Fella Robert Weede	8.60	8.60	5.90
The Reluctant Debutante Adrianne Allen Wilfrid Hyde White	6.85	6.85	*5.15

* Matinees Thursday

Checks should be made payable to: "Theater Ticket Committee, AIEE." Requests also should include first and second choice of both name and date of show, and should be sent to: Theater Ticket Committee AIEE, c/o S. Friend, Jr., 75 Buena Vista Drive, Dobbs Ferry, N. Y.

Smoker

A highlight of the Winter General Meeting will be the Smoker to be held Tuesday evening, January 22, 1957. Good food, good fellowship, and top quality entertainment will be the feature of this event which will take place in the Hotel Statler.

Attendance will be limited for the comfort of guests. Ticket requests should be mailed at an early date. The price remains at $10 per ticket and requests should be addressed to "AIEE Smoker Committee," 33 West 39 St., New York 18, N. Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

Dinner-Dance

A Dinner-Dance will be held Thursday evening, January 24, in the Grand Ballroom of the Hotel Statler. General arrangements will be the same as those which proved enjoyable last year. Dress will be formal. Write soon for reservations for tables for 10. The price this year is $12.50 per ticket and requests should be sent to "AIEE Dinner-Dance Committee" at 33 West 39 St., New York 18, N. Y., accom-

panied by checks made payable to "Special Account, Secretary, AIEE."

Inspection Trips

A program of 16 inspection trips is being arranged which will include, tentatively, the following places of general and technical interest: Radio City Music Hall, Tuesday morning; International Business Machines (3 Tours), Tuesday morning, Wednesday and Thursday afternoon; Brookhaven National Laboratory, Thursday all day; Ford Motor Company—Mahwah, Tuesday afternoon; Western Electric Company, Thursday all day; Merchant Marine Academy, Wednesday all day; Bell Telephone Laboratories, Tuesday afternoon; East River Generating Station, Tuesday; Steinway Piano Company, Wednesday morning; New York Coliseum, Thursday afternoon; Bulova Watch Company, Thursday morning; Fairless Steel Plant, Wednesday all day; Grumman Aircraft Engineering Corporation, Tuesday all day; Fisher Radio Corporation (Hi-Fi); Electrical Testing Laboratories, Inc.; and Lincoln Tunnel—3rd Tube.

Ladies Entertainment

The Ladies Entertainment Committee under the Chairmanship of Mrs. C. T. Hatcher is arranging a full program for the Winter General Meeting of the AIEE. Included will be two tours of New York City with stops at outstanding places of historical and architectural interest, followed by luncheon at a famous old restaurant in lower New York.

A Welcoming Tea on Monday afternoon, a luncheon and style show at the Ambassador Hotel, breakfast at B. Altman's and other activities will complete the program.

All ladies must register with their husbands first, then bring their badges in order to sign up for the program at Ladies Headquarters in the Washington Room. Registration will be held from 2–4 p.m. on Sunday afternoon, January 20, 1957.

Winter General Meeting Committee

Members of the 1957 Winter General Meeting Committee are: D. M. Quick, chairman; R. T. Weil, Jr., vice-chairman; J. J. Anderson, secretary; L. F. Stone, budget co-ordinator and AIEE vice-president for District 3; W. R. Clark, chairman Technical Operations Department; F. S. Black, public relations; W. A. Clark, general session; D. V. Buchanan, hotel accommodations; F. L. Williams, registration; J. A. Mulligan, inspection trips; R. R. Meola, monitors; H. B. Snow, smoker; W. F. Anselm, dinner-dance; S. Friend, Jr., theater and broadcast tickets; Mrs. C. T. Hatcher, ladies entertainment; and A. J. Cooper, ex-officio member (past chairman).

New Attendance Record Set at AIEE Fall General Meeting

ONCE AGAIN Chicago, Ill., was host to the AIEE Fall General Meeting on October 1–5, 1956, with headquarters and sessions in the Morrison Hotel. This year, attendance records were broken: 2,055 members, their wives, and guests enjoyed the technical sessions, the inspection trips, and the social events.

The subjects covered in the 39 technical sessions were varied; as usual, several sessions were required to present the number of papers which had been accepted. For instance, there were six sessions devoted to rotating machinery; three for system engineering; and two sessions each for television and aural broadcasting, mining and metal industry, transmission and distribution, etc.

Inasmuch as the Fall Meeting's theme was the Nikola Tesla Centennial, it was fitting that on the first day of the meeting, the Tesla Society sponsored a luncheon, and, in the general session that followed, R. C. Sogge, AIEE delegate to the Tesla Centennial Celebration in Yugoslavia, reported on his trip.

On Tuesday afternoon, the newly created Members-for-Life Fund Medal in Electrical Engineering Education was awarded to Dr. F. E. Terman, provost of Stanford University.

President M. S. Coover, who presided at the special meeting, remarked that the occasion established another milestone in the annals of the Institute. He introduced Dr. W. C. White of Northeastern University, chairman of the Members-for-Life Fund Committee, who told about the plans leading up to the establishing of this medal (see accompanying illustration) as an award for eminence in the teaching of electrical engineering. He said that the committee had a difficult task in the selection of the first recipient from the 17 names submitted as candidates for the honor. This was followed by an account of Dr. Terman's accomplishments in the field of electrical engineering.

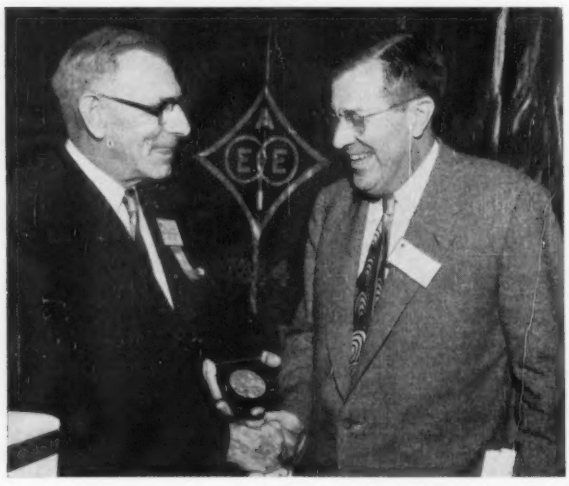
President Coover then presented the medal to Dr. Terman, who responded with a talk on "Electrical Engineering Curricula in a Changing World." (*Electrical Engineering*, October 1956, pages 940–2.)

On Thursday, Dr. C. F. Kettering was honored at a luncheon in the Terrace Casino in celebration of his 80th birthday with the presentation of another newly established award named for him. (See this issue of *Electrical Engineering*, page 1114.)

On the social side, there was a Get-Acquainted Tea Sunday afternoon before the meeting started; on Tuesday evening a combined party with the National Electronics Conference; and on Wednesday evening, the AIEE Fall Frolics. All of these events were greatly enjoyed by the members and guests, as were all the arrangements for the entertainment of the ladies.

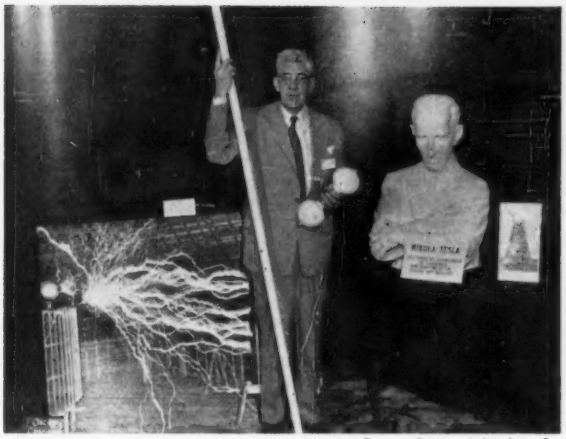
General Session

Dr. E. R. Whitehead, chairman of the Chicago Section, opened the session and introduced W. M. Ballenger, chairman of the General Committee of the meeting. He, in turn, introduced G. L. Ramsey, Commissioner of Buildings for the City of Chicago, Ill., who welcomed the AIEE members and



Courtesy Oscar and Associates, Inc.

AT A SPECIAL SESSION (*photo left*) held Tuesday afternoon, October 2, 1956, during the AIEE Fall General Meeting, Chicago, Ill., Dr. F. E. Terman (*right*), provost of the University and dean of the School of Engineering, Stanford University, received the newly established AIEE Members-for-Life Fund Medal in Electrical Engineering Education (*photo above*). M. S. Coover (*left*), president of the AIEE, presented the medal to Dr. Terman. After the presentation, Dr. Terman delivered an address entitled "Electrical Engineering Curricula in a Changing World."



Courtesy Oscar and Associates, Inc.

Courtesy Chicago Photographers

DR. S. G. HIBBEN (above *left*) holds one of Tesla's fluorescent "dumb-bells" and a modern fluorescent lighting tube. On the right is a bust of Tesla by Stevan Segvich of Yugoslavia. On the left is a photograph of one of Tesla's high-voltage experiments. Dr. Hibben (above *right*) explains how Tesla's idea of atomic excitation producing visible light was, in effect, the forerunner of the electroluminescent panel which he is holding. In the upper right-hand side of the photograph is a schematic diagram which illustrates the operation of Tesla's basic coil.

guests to the City. Mr. Ramsey brought out that Chicago had a great interest in Nikola Tesla as it was there, at the World's Fair of 1893, that he had a working exhibit of his a-c system as well as a personal exhibit of fluorescent tubes, induction coils, an electric clock, etc.

AIEE President M. S. Coover responded, asking Mr. Ramsey to extend the thanks of the Institute to Chicago's Mayor R. J. Daley for his proclamation making October 1 Nikola Tesla Day. Then he went on to tell about the Institute's new organization, which was explained in a chart on pages 858–9 of the September 1956 issue of *Electrical Engineering*.

R. C. Sogge was next introduced having been the AIEE delegate to the Tesla Centennial Celebration in Yugoslavia last summer. He told about his pleasant experiences in Belgrade and read a long list of the distinguished scientists who attended the celebration. He was given a painting of Tesla's birthplace which he presented to the Institute, as well as a bound volume of Tesla's papers, letters, etc. President Coover thanked him on behalf of the Institute.

Dr. G. Hibben then presented the main address of the meeting, "Tesla's Contributions to Today's Arc and Vapor Illuminants," in which he demonstrated with modern equipment some of the fundamental spectacular experiments on which Tesla had worked. Dr. Hibben stated that Tesla was a dreamer and if scientists two decades ago had interpreted some of his dreams of fluorescent lamps correctly, that phase of our lighting would be further ahead today. He said that Tesla and Thomas Edison had held divergent views on light sources; Edison held that incandescent wires were the only means of producing light from electricity, while Tesla maintained that atomic structures could be excited and so produce light. In the descriptions of the demonstrations which he performed, Dr. Hibben told why and how Tesla had come to do them originally and how they tied in with present-day thinking. (For further information on Nikola Tesla, see September 1956 *Electrical Engineering*, pages 786–90.)

Technical Sessions

Land Transportation. At a Monday morning session devoted to land transportation, E. A. Foster presided. The first paper on the program dealt with supplying energy for commercial-frequency railroad electrification and was presented by J. C. Price of the General Electric Company. The paper reviewed the problems associated with the provision of commercial-frequency power for traction purposes in single-phase blocks, and the technology and practices which have developed as an approach to these problems.

A. V. Johansson of the General Electric Company described the design fundamentals of diesel-electric locomotive control systems.

In a conference paper by C. W. Martin of the Baltimore and Ohio Railroad and H. S. Ogden of the General Electric Company,

Courtesy Chicago Photographers

Courtesy Chicago Photographers

WITH A MODERN 96-inch fluorescent tube, Dr. Hibben (above *left*) illustrates Tesla's theory of lighting with beamed radiations from a high-frequency generator at the left. With a few drops of sky-writing fluid on his fingers, Dr. Hibben (above *right*) dramatically causes a gas-filled sphere to fluoresce in the field of a high-frequency oscillator under the table. These demonstrations were part of Dr. Hibben's address "Tesla's Contribution to Today's Arc and Vapor Illuminants," which was presented at the general session held during the AIEE Fall General Meeting.

R. C. SOGGE, AIEE Tesla representative, addressing the gathering at the Tesla Centennial Celebration in Belgrade, Yugoslavia. Mr. Sogge told about his pleasant experiences in Belgrade during the general session of the Fall General Meeting.

proposed standardized wiring diagram symbols for land transportation vehicles were discussed.

The successful use of an ultrasonic reflectoscope to reduce railway accident risk through the detection of defective car axles and journal areas in the field was described by E. R. Hauer and C. M. Angel of the Chesapeake and Ohio Railway Company.

Safety. In the Tuesday morning session on safety, two papers were given which dealt with emergency lighting by storage and dry batteries. S. K. Geiges, Underwriters' Laboratories, Inc., presented, "Electric Shock Hazard Analysis," which considered the various voltages and currents which were harmful to users and which play a vital part in the design of electric equipment. In the discussion of this paper, Dr. W. B. Kouwenhoven stated that the theory of heart fibrillation due to electric shock had been upset when very short shocks were tried and that the thinking on this subject would have to be revised.

Television and Aural Broadcasting. A number of interesting papers were presented at a Tuesday morning session sponsored by the Committee on Television and Aural Broadcasting Systems. L. E. Anderson of the Radio Corporation of America described the closed circuit color television installation at the Walter Reed Army Medical Center, Washington, D. C.

R. W. Gast of the New York Telephone Company presented a paper on the new *A2A* video transmission system developed for use on local wire channels in television network service.

Work done in the Chicago, Ill., area in r-f diplexing in color television and aural relaying was described by T. G. Custin of the General Electric Company.

The first paper of the afternoon session on television and aural broadcasting was presented by O. W. B. Reed, Jr., of Jansky and Bailey, entitled, "Television Allocation Trends." This was a brief review of allocation trends since 1945 and the growth of the broadcast service since that time. The speaker also traced the other services in the frequency spectrum between 30 and 3,000 mc, which includes the vhf and uhf bands. New regulations, recently put into effect, allow channel assignments on a transmitter-site-to-transmitter-site basis rather than on the city-to-city basis used up to about a year ago. Current standards also provide for offset carrier operation of television transmitters which made a 28-db cochannel interference ratio practical for existing considerations as contrasted to the 100:1 (40 db) ratio in use in 1945.

In his paper on tropospheric scatter, William Collins, Page Communication Engineers, described the outages in and the reliability of various communication systems and compared them with scatter propagation. He described the diversity equipment and the data for any new stations.

George Moore, Zenith Radio Corporation, described the new portable all-transistor pocket receiver and some of the major problems which arose in its design. A great many variations were found in the characteristics of the different types of transistors and the final printed circuits were designed with these variations in mind.

Insulated Conductors. A Tuesday afternoon session sponsored by the Committee on Insulated Conductors was opened with a paper by P. J. Croft of the Canada Wire and Cable Company, Ltd., on the subject of aluminum sheathed cable. A system of utilization wiring for industrial, commercial, and domestic buildings, based on the use of aluminum sheathed cable and fittings, was described and evaluated.

A paper by M. M. Brandon, K. S. Geiges, L. M. Kline, and F. V. Paradise of Underwriters' Laboratories, Inc., covered the heating and insulating effects of installing insulated conductors in steel raceways (see November 1956 *Electrical Engineering*, pages 1,000–04).

H. A. Hoover of John A. Roebling's Sons Corporation discussed the properties and advantages of tellurium alloy lead sheath for power cable. This alloy has excellent fatigue resistance and creep resistance, it may be extruded over a wide range of temperatures without changes in properties, and it has some superiority over copper bearing lead under conditions of electrolytic and direct chemical attack.

D. M. Farnham of the Quebec Hydro-Electric Commission reviewed the findings of a survey conducted to obtain information on anticorrosion coverings presently available for metallic-sheathed cable and pipe.

A paper by R. C. DeMarco and J. E. Johnson of the Philadelphia Electric Company described that company's experience with corrosion control on its underground system. The majority of the failures were caused by anodic corrosion as the result of the flow of direct current from the cable sheaths to the adjacent environment.

Telegraph Systems. At a Wednesday morning session sponsored by the Committee on Telegraph Systems, four papers were presented. A paper by C. R. Doty and L. A. Tate of International Business Machines Corporation described a new machine, the "Data Transceiver," designed to meet the requirements for rapid and accurate transmission of all types of data. Transmission may be over either telephone or telegraph circuits, using wire, radiotelegraph, or microwave.

C. J. Holloman of the Western Union Telegraph Company outlined the features of the *56-A*, a high-speed fully automatic teleprinter switching system for use by brokerage firms.

F. D. Biggam, Teletype Corporation, described a developmental time-division

Courtesy Chicago Photographers

IN FRONT OF A BUST OF NIKOLA TESLA, whose centennial was the theme of the Fall General Meeting, are (*left to right*) W. M. Ballenger, general chairman; R. C. Sogge, AIEE Tesla representative to Yugoslavia; M. S. Coover, AIEE president; and S. G. Hibben.

multiplex equipment which, through the use of transistors, has only 20 per cent of the volume, 20 per cent of the weight, and 5 per cent of the power consumption of the equivalent vacuum-tube set now in service.

Transmission of newspapers by facsimile transmission over a wide-band channel was the subject of a paper by A. G. Cooley and J. R. Shonnard of the Times Facsimile Corporation. Mr. Shonnard described the recent high-speed facsimile transmission of a special edition of *The New York Times* for publication at San Francisco, Calif., during the Republican National Convention, and distributed copies of the newspaper to those attending the session.

Communication Theory. In the session on communication theory, Wednesday morning, four papers of great interest were presented. The first, dealing with the feasibility of using a machine to translate languages, was by V. H. Yngve of Massachusetts Institute of Technology and appeared on page 994 of the November 1956 *Electrical Engineering*. The second, on visual perception speed, by G. C. Sziklai of the Radio Corporation of America will run in a future issue.

W. T. Rea, Bell Telephone Laboratories, presented for discussion "The Communication Engineer's Needs in Information Theory" in which he set forth some of the further breakdowns in the theory that are needed for better understanding on the part of engineers. He calls for more and better courses in the theory; more ready access to new results; more thorough exposition; and finally, development of the subject in directions useful in the communication art.

Feedback Control Systems. Four papers were presented at a Wednesday afternoon session devoted to feedback control systems. P. N. Nikiforuk of the Canadian Armament Research and Development Establishment discussed the response of a particular nonlinear control system to random signals.

M. Y. Silberberg of Yale University reported on the describing function of an element with coulomb, static, and viscous friction.

The sampled-data analysis of a drift-stabilization system was discussed in a paper by P. G. Pantazelos of Massachusetts Institute of Technology.

Bernard Friedland of Columbia University described a method for analyzing sampled-data systems containing time-varying components. Inasmuch as only two simple mathematical operations are involved—matrix multiplication and solution of single linear algebraic equations—they can be performed by relatively unskilled personnel or by digital computers.

System Engineering. In two sessions on Thursday devoted to system engineering and computers, eight papers were presented with the idea of acquainting engineers with the use of computers and how their use could assist those men who are concerned with system problems. In the first session, fundamental concepts of computers were considered, the personnel who would use them, and elementary problem preparation. In the afternoon session, specific problems and how they could be solved more easily by computers than they are at present were discussed.

F. J. Maginniss of the General Electric Company opened the Thursday morning session on system engineering with a broad description of the most obvious applications of digital computers in the electrical utility field. He urged utilities to start training personnel to study ways in which computers can be used to solve day-to-day problems, so that when the time comes that the organization can justify a computer for this type of use, a backlog of problems will be ready that could be solved by digital computers with which company personnel have become familiarized.

In his paper "What Is a Digital Computer?" H. A. Peterson, University of Wisconsin, defined a digital computer as a tool which is a worthy end to better understanding of increasingly complex physical problems and relationships. However, he warned, the computer has drawbacks, including the inability to think up problems.

E. L. Harder of Westinghouse Electric Corporation discussed the elements of problem preparation. He emphasized the need for effective determination of the suitability of a particular line of work for a computer.

E. R. Moore, Detroit Edison Company, outlined his company's experience in the use of computers. He discussed the general problems encountered in setting up an organization to handle this new type of activity.

Wire Communications Systems. A Thursday afternoon session sponsored by the Committee on Wire Communications Systems was opened with a conference paper by E. E. Combs of the Lynch Electric Company on the treatment of wire lines for radio and multiplex application.

A paper by G. Goltsos and J. H. Johnston of the Signal Corps Engineering Laboratory and R. B. Anderson of the Lenkurt Electric Company discussed a new converter-repeater, the *AN/TCC-6*, developed for use with existing military telephone carrier equipment.

T. F. Palmquist, Bell Telephone Company of Canada, described the features and operation of multiunit neutralizing transformers.

The final paper of the session, by R. C. Dowling of the Wisconsin Telephone Company, described the lightning protection on the Stevens Point–Wisconsin Rapids intercity telephone cable. The method adopted consisted of the insulation of full count carbon gap protection at various intervals along the route of the buried cable.

Industrial Control. A Friday morning session devoted to industrial control was opened with a paper by F. P. Brightman, P. J. Reifschneider, and R. R. McGee of the General Electric Company. The paper, presented by Mr. Brightman, discussed the effectiveness of direct acting series trips used on low-voltage air circuit breakers as a means of protecting squirrel-cage motors in the event of locked or stalled rotor, overheating resulting from prolonged moderate overloads, or short circuit in the motor or its connections.

J. P. Conner of the Westinghouse Electric Corporation described the application of magnetic logic elements to the control of an automatic bus-duct welder. He showed an interesting film demonstrating the use of these elements in place of conventional relays for control purposes.

A 2-pole single-throw pressure control switch using silicone fluid viscous damping to prevent the transmission of pressure pulsation from a pump outlet system to the pres-

Future AIEE Meetings

AIEE-IRE-MSU Midwest Symposium on Circuit Theory*
Michigan State University, Lansing, Mich.
December 3–4, 1956

AIEE-IRE-ACM Eastern Joint Computer Conference*
Hotel New Yorker, New York, N. Y.
December 10–12, 1956

AIEE-IRE-RETMA-ASQC Symposium on Reliability and Quality Control*
Hotel Statler, Washington, D. C.
January 14–16, 1957

Winter General Meeting*
Hotel Statler, New York, N. Y.
January 21–25, 1957

AIEE-IRE-U of P Conference on Transistor and Solid State Circuits
Philadelphia, Pa.
February 14–15, 1957
(*Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Dec. 12*)

AIEE-IRE-ACM Western Joint Computer Conference
Hotel Statler, Los Angeles, Calif.
February 26–28, 1957
(*Final date for †TP—closed, ‡CP Syn.—Dec. 14, CPMs—Dec. 24*)

Textile Conference
Georgia Institute of Technology, Atlanta, Ga.
(*Final date for †TP—Dec. 7, ‡CP Syn.—Dec. 22, CPMs—Jan. 2*)

EJC Nuclear Engineering and Science Congress
Convention Hall, Philadelphia, Pa.
March 11–15, 1957
(*Final Date for †TP—Dec. 12, ‡CP Syn.—Dec. 27, CPMs—Jan. 4*)

AIEE-ASME Engineering Management Conference
Pittsburgh, Pa.
March 27–28, 1957
(*Final date for †TP—Dec. 28, ‡CP Syn.—Jan. 11, CPMs—Jan. 22*)

Paper and Pulp Conference
Georgia Institute of Technology, Atlanta, Ga.
March 28–29, 1957
(*Final date for †TP—Dec. 28, ‡CP Syn.—Jan. 11, CPMs—Jan. 22*)

Southern District Meeting
Hotel Heidelberg, Jackson, Miss.
April 3–5, 1957
(*Final date for †TP—Jan. 3, §DP Syn.—Jan. 20, DPMs—Jan. 30*)

Great Lakes District Meeting
Des Moines, Iowa
April 15–17, 1957
(*Final date for †TP—Jan. 15, §DP Syn.—Jan. 30, DPMs—Feb. 8*)

*Final date for submitting papers—closed
†**TP**—Transactions paper
‡**CP Syn.**—Conference Synopsis
CPMs—Conference Manuscript
(The CPSyn. date is 10 days before the CPMs date)
§**DP Syn.**—District Synopsis
DPMs—District Manuscript
(The DPSyn. date is 10 days before the DPMs date)

sure control system was described by L. P. Schaefer of the Hinchman Corporation.

W. Kniel of the Allen-Bradley Company described an improved method of phase failure protection which overcomes the disadvantages inherent in thermal-relay systems.

Education in Electronics. In the seminar on education in electronics, the main thought which was brought out was that the large corporations not only are well aware that their personnel need more than just a bachelor's degree, but also are doing something about it, financially speaking. For instance, International Business Machines Corporation (IBM) has an arrangement with the Syracuse University Extension department in Endicott, N. Y., wherein IBM personnel in that city can study for master's degrees. Also, they have a post-doctorate program whereby the firm takes men into their research laboratory for a year to continue work on their theses, although they are not on the IBM payroll.

The Bell Telephone Laboratories have a wide educational program, too. For example, in the 1945–55 period, 41 fellowships of post-doctorate status were granted. In 1955, 15 fellowships were granted to encourage the study of electronics and communication with $2,000 being given to the college of the man's choice and the same amount to the student.

In most instances, no strings are attached to these grants; the recipients are not obliged to return to the company's employ when their studies have been completed.

Board of Directors Fall Meeting Held in Chicago, Ill., October 5, 1956

THE BOARD OF DIRECTORS held its regular Fall Meeting on the last day of the 1956 Fall General Meeting in Chicago, Ill. Twenty-five members of the Board were present and three Department Chairmen. The agenda was arranged to conform to the new departmental type organization with the five departments each reporting for their several committees. Other business was introduced by the standing committees of the Board—Finance, Planning and Co-ordination, Constitution and Bylaws.

Treasurer's Report

The Treasurer's report showed a balance in the General Fund at the end of August of $414,143 as against $389,808 at the same time last year. In view of the favorable outcome at the end of last year it would appear that the finances of the Institute are currently in a satisfactory condition.

Finances

In addition to a number of generally routine matters, the Finance Committee reported that it is investigating the proposal that the Institute make available to its members some form of group insurance covering accidents, disability, and income continuation which is reputed to be available at advantageous premiums to large groups of professional people. On the recommendation of the Finance Committee, the Board approved a modern type of group life insurance plan for the AIEE employees at Headquarters. The exchange allowance for foreign members, which was discontinued at the April 1956 Meeting of the Board of Directors, was reported as having brought a number of communications from overseas members which the Finance Committee is studying, but on the basis of which it has so far found no reason to recommend any revision of the action.

The basis for calculating travel allowances for delegates and representatives of the Sections and Districts of the Institute was adjusted so as to use ruler measured distances on an accurately scaled map in place of railroad tables previously used. The rates have been readjusted so that the net results should be the same except for a considerable saving in the time required to make up the vouchers.

A new member has been appointed to the Finance Committee. C. H. Linder, a member of the Board of Directors, vice-president, General Electric Company, was confirmed by the Board of Directors as a fourth member of the Finance Committee on recommendation of that committee.

Constitution and Bylaws

Bylaw No. 37 was amended, by vote of the Board of Directors, to provide the addition to the District Executive Committees of a member appointed by the Chairman of the Technical Operation Department for the purpose of promoting and co-ordinating the development of Technical Groups in the Sections of each District. The appointee in each case must be a resident of the District.

Progress was reported on the editorial revision of the Constitution and Bylaws which is proceeding rapidly with the expectation of submitting any changes judged by the Board to be desirable in the Constitution to the membership next June.

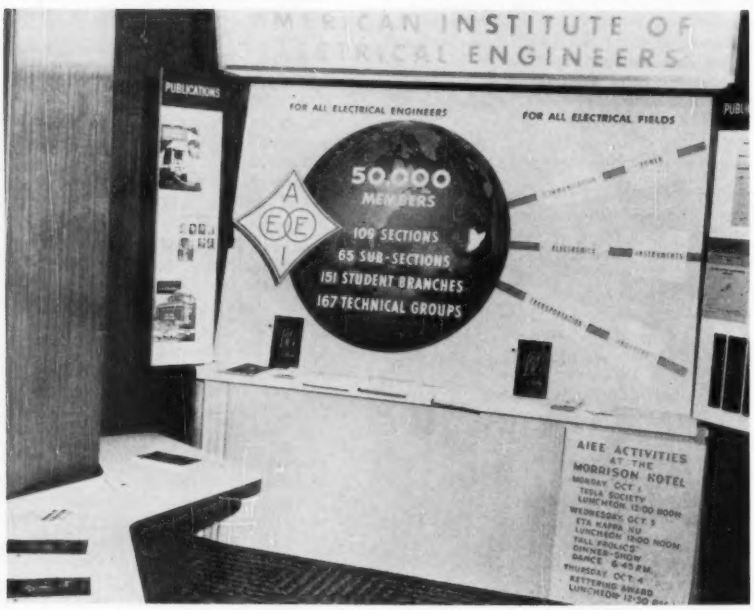
Planning and Co-ordination

In addition to severe recommendations intended for future implementation and complete report, Chairman L. F. Hickernell of the Planning and Co-ordination (P and C) Committee submitted to the Board the following statement of the current intentions of the P and C Committee: "It is expected that the new P and C Committee will devote its major efforts to "planning," leaving "co-ordination" up to the five departments, except matters which involve two or more departments. Organization and finance will continue to receive the committee's major attention in an effort to effect further improvements in the Institute's operations and procedures."

Conference of Vice-Presidents

A conference of the Vice-Presidents was held on Thursday, October 4, the day before the Board Meeting. It appears that these conferences are favorably regarded by the

New AIEE Booth



THE NEW AIEE BOOTH as installed at the National Electronics Conference, Sherman Hotel, Chicago, Ill. It is expected that this booth will be shipped to various conferences and meetings; from it are distributed AIEE membership application blanks and other Institute literature.

Vice-Presidents and are likely to become a regular thing preceding most of the Board Meetings. The Vice-Presidents take this opportunity to exchange experiences and to co-ordinate the work of the 11 Districts over which they preside. It was reported that 7 of the 11 Districts are planning to hold the two District Executive Committee Meetings authorized last year by the Board of Directors.

Engineering Societies Center

In view of the fact that the Report of the Special Task Committee of the Founder Societies and American Institute of Chemical Engineers (AIChE) for the selection of a new Engineering Societies Center Building site has been approved by the Four Founder Societies and agreed to in principle by AIChE; the Board voted to discharge its three representatives on the committee and to approve the request of the whole committee that it be dissolved. The Board voted its compliments to the committee on the completion of its mission and extended its thanks.

W. J. Barrett, AIEE representative, and president of United Engineering Trustees (UET) reported that under the authority voted to UET by the Founder Societies in approving the Report of the Special Task Committee, UET has initiated active steps toward carrying out its assignment and raising the funds with which to erect a new and enlarged Headquarters' structure for the five participating societies eventually.

Engineering Profession Survey

Further, in the matter of intersociety activities, the Board voted to approve a project to be carried out under the auspices of Engineers Council for Professional Development (ECPD) and Engineers Joint Council (EJC). The project is a comprehensive survey of the engineering profession similar to surveys that have been conducted with excellent results by the medical and legal profession. The preliminary plans and proposals which were submitted to the Constituent Societies of ECPD and EJC were worked out by a committee headed by AIEE Past President M. D. Hooven. In approving this project, AIEE also appropriated its share of the funds for proceeding, contingent on the other societies making similar appropriations, and the total amount needed being raised.

Manual for Consulting Practice

The Board heard a report from Frank Sanford and Vice-President J. H. Foote on proposals to prepare a general "Manual for Consulting Practice." It was the concensus of the Board that although the general professional conduct and ethics to be laid down by such a manual could readily be stated for all of the engineering fields, there exist special considerations with respect to consulting practice in the several different fields which should be thoroughly explored before endorsement is given to an over-all statement.

Technical Groups in the Sections

The Administration Department reported that 62 of the Sections had responded to the postal card survey to determine the member interest in the formation of Technical Groups in the Sections. Forty-nine new Technical Groups appear to be in immediate prospect to be added to the 120 now known to be operating. J. C. Strasbourger, chairman of the Administration Department, sees the prospect of many more new Technical Groups being formed on the basis of the returns to date and considers the program to hold promise of considerable growth in Institute membership and activity.

National Electrical Week

On recommendation of the Administration Department, the Board voted ". . . to join in the support of the annual observance of National Electrical Week, endorsing the idea with the understanding that no financial obligation is involved."

EJC Representatives

The following Representatives were appointed to the Board of Directors of Engineers Joint Council (EJC) to take office on January 1, 1957: L. F. Stone, L. F. Hickernell, T. M. Linville, M. D. Hooven, and J. D. Tebo. The following were elected Alternates to the Board of Directors of EJC: F. S. Black, E. I. Green, J. P. Neubauer, W. B. Morton, and H. I. Romnes.

Responsibility of Departments

In keeping with and to make completely effective the new departmental organization of the Institute's administration, the Board voted the following resolution:

> "RESOLVED; that it is the desire of the Board of Directors that the various departments, into which the Institute has now been divided, be charged with the responsibility for administrating the policies set up by this Board; and that this carry with it the right to delegate responsibility and authority within these departments, as the respective departments see fit."

By the passing of this resolution, the Board made clear its intent to delegate authority and responsibility to the departments for making decisions and implementing and carrying out the management of the Institute within the policies provided by the Board of Directors. This is an entirely new concept of Institute management under which it is expected that the General and Technical Committees will proceed directly to put into effect measures to accomplish their purposes under the Institute's policies determined by the Board.

Under this new policy, it was announced that the Sections Committee, with the concurrence of the Vice-President of District No. 9, had approved the formation of the Victoria Section as the 110th on the rolls of the Institute. The Victoria Section will have as its territory Vancouver Island, B. C., Canada where the members and officers of the new Section have been carrying on for some time as the Vancouver Island Subsection.

New Members and Transfers

The Admissions and Advancements Department reported the following additions to the several grades of membership: Members—188; Associate Members—418; Affiliates—54; Student Associates—59; Student Affiliates—4. Ten Members were elected by unanimous vote of the Board to be Fellows of the Institute. Their names, pictures, and biographies will appear in an early issue of *Electrical Engineering*.

Kettering Award

The Board of Directors confirmed the appointment of Past President M. D. Hooven and Chairman B. G. A. Skrotzki of the Prize Awards Committee, to be AIEE Representatives on the Charles Franklin Kettering Board of Award. These two Representatives attended the first meeting of the Kettering Board of Award on Thursday, October 4, as a part of the first Kettering Award Program described on page 1114 in this issue of *Electrical Engineering*. AIEE's participation in the Kettering Award Program is under the direction of the Professional Development and Recognition Department, of which Dr. W. A. Lewis, Jr., is Chairman.

Additional District Student Paper Prizes

Dr. Lewis also reported that the Members-for-Life Fund Committee had provided additional prizes for District Student Prize Paper Contests. The second prize of $25 and the third prize of $15 will be made available to each of the Districts for this purpose. The first prize of $25 offered by the Institute is also augmented by an "all expense" trip to the Summer General Meeting.

Joint Student Branch Chairmen

The Board of Directors, by amendment to the Bylaws, and by special resolution, reaffirmed its belief that the Chairman of a Joint Student Branch should be a member of both of the sponsoring engineering societies supporting the Branch. It was made clear that there was no intention that the student should be a member of more than one society, prior to his election as Chairman of a Joint Branch, and that the Institute intended, assuming concurrence by other supporting organizations, to make the second membership available to the Chairman of a Joint Student Branch without additional personal cost to him.

Professional Development and Recognition

The Professional Development and Recognition Department announced that it is working on a statement of policy which will distinguish between certificates of appreciation, which various units of the Institute may wish to give to members or others who provide some special valuable service to the Institute, or one of its activities and, on the other hand, citations and awards expressing judgment on the career or an achievement of the individual in the name of the institute. The latter is a function to be reserved through the various Medal and Prize Awards Committees of the Institute working under the scope of the Professional Development and Recognition Department.

Publications

The Publications Department announced its approval, in which the Finance Department joined, of changes in the arrangement for the printing of *Electrical Engineering* through which substantial economies are to be achieved. It also announced the creation of Subcommittees on Periodicals and Transactions, Educational Publications, Special Publications, and Surveys.

Technical Operations

Dr. W. R. Clark, chairman of the Techni-

cal Operations Department (TOD), announced that the authority previously held by the P and C Committee for approving District Meetings and the dates for General Meetings had been transferred to the TOD and would this year be under the direction of Dr. J. D. Tebo, vice-chairman of TOD. Dr. Tebo will receive and co-ordinate all invitations for the holding of General and District Meetings of the Institute. It will be the objective of TOD to continue the policy of the P and C Committee and the Board of Directors to schedule General Meetings five years in advance, and District Meetings, wherever possible, up to five years ahead. Dr. Tebo will receive and record for future action invitations for any future date.

A new policy has been instituted with respect to conference papers printed by the author. The author is now permitted to distribute such papers at the session where the papers are read provided 50 copies are supplied to the Institute for sale at the regular booth, and to supply orders received after the meeting.

Dr. Clark announced the appointment of Representatives of TOD on the 11 District Executive Committees in accordance with the provisions of Bylaw No. 37, referred to earlier in this report. He also gave the Board of Directors a list of nine functions which these TOD Representatives are expected to perform in the District to whose Executive Committees they are appointed.

TOD presented a forecast of sessions and papers for the current administrative year which, in general, are expected to be of the same order as in 1955–56. It was announced that the 1957 Winter General Meeting will feature a review of the achievements of Dr. Lee de Forest.

Institute Nominating Committee

The Board of Directors, under its Constitutional privilege, elected six Representatives to serve on the Institute Nominating Comittee, which will meet on the morning of the first day of the 1957 Winter General Meeting, January 21, 1957. The Representatives of the Board of Directors will be B. G. Ballard, W. R. Brownlee, Bradley Cozzens, C. T. Pearce, J. D. Tebo, and J. C. Wood. Elected to serve as Alternates for these Representatives were the following four members the Board of Directors: J. H. Foote, L. M. Robertson, D. I. Cone, and M. D. Hooven.

Fall General Meeting

The Board unanimously and enthusiastically voted a resolution of thanks and commendation to the 1956 Fall General Meeting Committee and to the officers and members of the Chicago Section for their work in organizing and carrying out the 1956 Fall General Meeting, which had the largest registration recorded—2,055.

Next Meeting

The next meeting of the Board of Directors will be held at Institute Headquarters on Friday, January 25, 1957. The Spring Meeting will be in connection with the District No. 4 Meeting in Jackson, Miss., on Friday, April 5, 1957. Invitations for future Board Meetings were received from District No. 9 in connection with the 1957 Pacific General Meeting to be held in Pasco, Wash., August 28–30, 1957, and from the Washington, D. C. Section, which will be host to the 1958 District No. 2 Meeting, April 28–30, 1958.

Engineering Societies Present Award to C. F. Kettering

DR. KETTERING, director and former vice-president of General Motors Corporation, was honored by the six leading engineering societies on October 4 when he was presented with an award at a luncheon held during the Fall General Meeting of the AIEE.

The award, which is called The Charles Franklin Kettering Award, is sponsored by the AIEE, American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society of Mechanical Engineers, the American Institute of Chemical Engineers, and the Society of Automotive Engineers. This was the first time the award has been presented. It is planned that the award will be made annually to an outstanding engineer ". . . for creative accomplishments for the benefit of mankind, including discovery, invention, improvement in designs or processes within the relationship of materials and energy."

Courtesy Oscar and Associates, Inc.

C. F. KETTERING (*second from right*), director and former vice-president of General Motors Corporation, received the newly established Charles Franklin Kettering Award at a luncheon held during the AIEE Fall General Meeting. Among those who honored Dr. Kettering at the luncheon were (*left to right*) E. G. Bailey, founder and chairman of the Bailey Meter Company and director of Babcock and Wilcox Company; M. S. Coover, president of AIEE; and Dean A. A. Potter of Purdue University.

M. S. Coover, president of AIEE, introduced the heads of the other five societies and honored guests. Dean A. A. Potter of Purdue University described Dr. Kettering as "one of the most useful leaders of our times," and said that this award was a means of honoring the inventor of the automobile self-starter by his friends and associates. To determine future recipients, a yardstick of achievement is needed and Dr. Kettering himself is this measure.

Dr. E. G. Bailey, founder and chairman of the Bailey Meter Company and director of Babcock and Wilcox Company, told some of the highlights of Dr. Kettering's career, starting with his first job with the National Cash Register Company when, in 1904, he electrified the cash register. In 1919, he began his life-long connection with General Motors Corporation of which organization he is still a director and consultant. Dr. Bailey said that Dr. Kettering's greatest contribution was his keen mind in determining today's problems.

D. Barnard, past president of the Society of Automotive Engineers, presented the award, signed by the presidents of the six participating societies, to Dr. Kettering. This read, "For pioneering inventions in the fields of applying materials and energy to practical uses, for stimulation of the inventive ideal in thousands of engineers and scientists, for contributions to our National Defense, for enlarging the co-operation between industry, research, and education, for enthusiastic selfless dedication to human relations and welfare, our societies have instituted The Charles Franklin Kettering Award and are now joined together to make this initial presentation to Charles Franklin Kettering."

Dr. Kettering in his response said that he never was anything but a mechanic and inventor, which nobody likes because he is not a specialist. He gave credit to the engineering societies because they are a means of distributing information, which is sorely needed in today's progressing world.

"Education today is too specialized," said Dr. Kettering. "If a kid has any originality, it is knocked out of him in school. We want him to read only one page of the encyclopedia, when he should read the whole book. It takes several highly spe-

cialized scientists to do a job now that one fellow could do 20 years ago. The difference is that this low-grade fellow would try anything. I'm for education but one of our greatest problems is that we try to standardize everybody. The ambition of every educator should be to educate people so that they can do anything.

"We overestimate the little that we do know and completely disregard the infinite we don't know."

"Boss Ket," as he is known to friends, explains that school testing and grading systems make youngsters more conscious of passing examinations than trying something new. "The inventor looks at failure as a practice stroke," he said. "The educated man looks at failure as a catastrophe."

Forum of Technical Committee Chairmen Held During the AIEE Fall General Meeting

THE EIGHTH FORUM of Institute Technical Committee Chairmen was held Thursday evening, October 4, with Dr. W. R. Clark presiding. He introduced AIEE President M. S. Coover who stated that he was gratified at the technical committees' work in the sections and subsections, as this work gets down to the individual member.

L. F. Hickernell next explained the new organization plan, which was started in 1947 and recently passed by the Board of Directors. The idea behind this reorganization is that more work is to be done in the departments with less by the Board of Directors (see pages 857–9, *Electrical Engineering*, September 1956). The scheduling of all meetings is to be done by the Technical Operations Department (TOD) and Mr. Hickernell outlined the work planned by the chairmen of the several departments. He then explained the functions of the representatives for the improvement of sections' work. They will establish technical groups with which they will keep in contact and forward information to TOD; in turn, they will send TOD data to groups and will keep them informed on data pertinent to their districts. It was brought out that AIEE has 118 technical groups with about 28,000 members attending their meetings.

E. C. Day spoke about the handling and processing of technical papers in his office and urged that these papers be sent through in accordance with the schedules as stated in *Electrical Engineering*.

Hendley Blackmon reported that the number of technical papers estimated for 1956–57 was approximately 4 per cent more than for the present year.

C. S. Rich spoke about the types of papers and articles he has been receiving for *Electrical Engineering*. He urged that the committee chairmen exercise care in the selection of technical papers recommended for the magazine, taking into consideration the fact that its readers have a broad general interest. He also asked that the short articles for the engineering review of the year, published annually in the January issue, be sent to him by the deadline specified.

Dr. Clark then said that a function of TOD is to sponsor technical conferences. He explained that committee chairmen could help these conferences greatly in many ways and that it was one of their duties to do this.

R. S. Gardner explained about the technical conferences and their growing importance to the Institute.

The question was raised as to the inclusion of panel discussions of general subjects at general or district meetings. Mr. Day expressed the opinion that these were not as successful as the technical conferences, giving as an example the air transportation conferences, which were held in cities where the interest was keen.

Annual AIEE Prizes in Various Classifications

THE FOLLOWING is a reminder of the awards which are available each year in each classification:

Institute Prizes

The awarding of the Institute prizes shall be the responsibility of the Committee on Prize Awards, which is appointed annually by the Institute President in accordance with the Bylaws. The Institute prizes will be presented at the regular Winter General Meeting.

The Institute or national prizes will consist of (a) one from each Division, (b) one for papers sponsored by general committees and articles in *Electrical Engineering*, and (c) a Best Student paper.

(a) *Division Papers:*

Only *Transactions* papers shall be eligible for Division prize awards. There shall be one first prize for each Division consisting of a certificate and $100. In special cases, additional certificates may be awarded at the discretion of the Committee on Prize Awards. All *Transactions* papers will be considered for Division prizes without formal offering in competition. The awards will be presented at the regular Winter General Meeting.

The Division prizes shall be judged by the Committee on Prize Awards upon recommendation of a Subcommittee on Prize Awards of each of the Divisions.

As an aid to the Committee on Prize Awards, a Subcommittee on Prize Awards shall be appointed by each Division chairman at the beginning of the administrative year and shall consist of not less than three members of the Division. Recommendations for Division prizes for papers presented during the administrative year shall be submitted by this Subcommittee to the Committee on Prize Awards not later than September 1 of the following administrative year.

To assist the Divisional Subcommittee on Prize Awards, each Technical Committee Chairman is urged to submit nominations for the National Prizes to his Divisional Subcommittee on Prize Awards, accompanied by a brief statement giving reasons why each paper is worthy of consideration.

(b) *Papers Sponsored by General Committees and Articles in Electrical Engineering:*

To encourage the authors of papers sponsored by general committees, and authors of articles in *Electrical Engineering*, an additional prize consisting of a certificate and $100 has been set up. All such papers will be considered for this award if submitted in triplicate to the Institute Secretary before July 31 of the administrative year and accompanied by a written statement as to why it is of prize caliber.

(c) *Best Student Paper:*

A Best Student Paper award also is included among the Institute awards. This consists of a certificate and $100. All student papers which have won a prize in Branch or District student competition will be considered for an Institute award if submitted in triplicate to the Institute Secretary before July 1 of the administrative year in which presented and accompanied by a written statement as to when and where presented.

District Prizes

The awarding of District prizes shall be the responsibility of the Committee on Award of District Prizes which shall be appointed annually by the District Vice-President and shall consist of not less than three Members or Fellows of the Institute. Judges of oral presentation of Student papers need not be the same as judges of written presentation, and they may include Associate or non-Institute members when necessary. The District prizes will be presented at a meeting within the District or at some other meeting upon approval of the District Executive Committee.

The District Prizes comprise (a) a best paper prize for any *Transactions* paper prepared by a resident of the District consisting of a certificate and $75, and a second prize consisting of a certificate and $50; and (b) a best paper prize presented to an undergraduate Student member in district competition consisting of a certificate and $25, and a second student prize consisting of a certificate only.

(a) *Best District* Transactions *Paper:*

All *Transactions* papers presented during the administrative year, nominally August 1 to July 31, will be considered for District prizes without formal offering in competition. *Transactions* papers selected by Technical Committees of the Divisions and the General Committees for consideration as Institute prize papers will be classified according to District allocation, as determined by the residency of the author or authors. In the case of member coauthors from more than one District, a *Transactions* paper shall be eligible in all such Districts. A list of these *Transactions* papers for each District shall be forwarded by the Headquarters staff to the District Secretary for consideration as the

District prize papers. In addition to these papers, each District may include for consideration as District prize papers, any eligible *Transactions* paper, whether or not it is among those called to their attention by Headquarters. A paper is eligible to receive both Institute and District prize awards.

(b) *Best Student Paper:*

The District Student Prize Papers competition is limited to papers which have received first prize in a Branch competition. (First prize is $25, and usually includes a trip to the Summer General Meeting; second prize is $25; third prize is $15.)

Section Prizes

The awarding of Section prizes shall be the responsibility of the Committee on Section Prizes which is appointed annually by the Section chairman and shall consist of not less than three Associate Members, Members, or Fellows of the Institute.

Prizes also are available for papers presented by Section members, but because of the wide variation in the character of the Sections, no very definite rules are provided. A sum of $100 is available for each Section to be divided at the discretion of the Section, but with a maximum of $50 for any one prize and a certificate for each winner. When three or more papers are submitted for competition to the Secretary of the Section, arrangements shall be made for presentation before the Section at a meeting set aside for that purpose and a committee selected to judge the contest.

The award of the Section prize will be made at a meeting of the Section.

Branch (Undergraduate) Prizes

The Committee on Award of Branch Prizes shall be appointed annually by the Student Counselor and shall consist of not less than three Associate Members, Members, or Fellows. When necessary, a non-Institute member may be selected.

Two awards for each Branch are available. The first prize consists of a certificate and $10 plus an allowance of 17.5¢ per mile one way for 600 miles or less and 13.5¢ per mile one way for the remaining distance to the district student prize paper competition. The second prize consists of a certificate. When three or more papers are submitted to the secretary of the Branch, arrangements shall be made for presentation before the Branch at a meeting set aside for that purpose and committees selected to judge each such contest.

It is not the primary purpose of Student papers to contribute to the technical advancement of the profession; they should constitute a vehicle for the training and stimulation of future contributors to the profession. To this end, emphasis has been placed on written presentation and the exercise of engineering thinking rather than on technical value.

Complete Rules

The complete rules for the award of prizes for AIEE technical papers appear in the September 1956 issue of *Electrical Engineering* pages 837–8.

Plans Made for 1957 Nuclear Congress

The 1957 Nuclear Congress, consisting of four major events, will be held in Philadelphia, Pa., March 11–15, 1957.

The Congress will include the second Engineers Joint Council (EJC) Nuclear Engineering and Science Congress, the fifth Atomic Energy for Industry Conference, the International Atomic Exposition, and the fifth Hot Laboratories and Equipment Conference.

Exhibits and conference sessions will cover the latest developments relating to the creation and utilization of atomic energy in its various nonmilitary forms for civilian use. All events will take place at Convention Hall, Philadelphia, Pa.

General chairman for the 1957 Nuclear Congress is Dr. W. G. Whitman, president of the American Institute of Chemical Engineers (AIChE) and secretary general of the United Nations "Atoms for Peace" conference in Geneva, Switzerland, in 1955. Program chairman is Bruce Prentice, manager of the atomic power department of the General Electric Company. Chairman of the Philadelphia Arrangements Committee is L. R. Gaty, vice-president of research and development, Philadelphia Electric Company.

The second EJC Nuclear Engineering and Science Congress, March 11–15, is sponsored and conducted by EJC in co-operation with 19 major engineering and scientific societies. Concurrent with the exhibit portion of the Nuclear Congress, there will be four simultaneous conference sessions each morning and afternoon at Convention Hall. Papers submitted during these sessions will describe the latest technical aspects in the field of atomic energy. All phases will be covered, from the mining of ore through measurement of atmospheric radioactivity and disposal of atomic waste.

EJC, the sponsor, includes the following societies: AIEE; American Society of Civil Engineers (ASCE); American Institute of Mining, Metallurgical and Petroleum Engineers (AIME); American Society of Mechanical Engineers (ASME); American Waterworks Association; Society of Naval Architects and Marine Engineers; American Society for Engineering Education; American Institute of Chemical Engineers; and American Institute of Industrial Engineers.

Also participating with EJC are: American Chemical Society, American Institute of Physics, The Institute of Radio Engineers, American Geological Institute, American Society for Metals, Institute of Aeronautical Sciences, Society of Automotive Engineers, American Society for Testing Materials, and Federation of Sewage and Industrial Wastes Association.

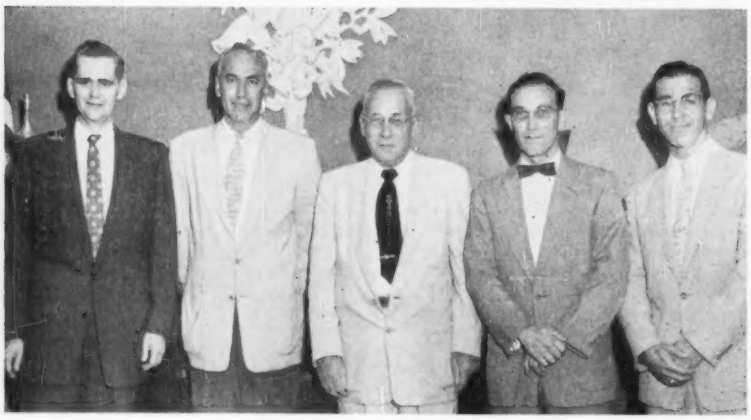
Executive secretary of EJC is E. P. Lange. The Operating Committee for the Congress Sessions is composed of F. J. Van Antwerpen, secretary, AIChE; N. S. Hibshman, secretary, AIEE; C. E. Davies, secretary, ASME; Ernest Kirkendall, secretary, AIME; and W. H. Wisely, secretary, ASCE. For information on this portion of the Congress contact T. A. Marshall, Jr., ASME, 29 West 39th St., New York 18, N. Y.

The fifth Atomic Energy for Industry Conference, consisting of management level meetings, March 14–15, is sponsored and conducted by the National Industrial Conference Board (NICB), Clark Thompson, secretary. For information contact E. A. Hammesfahr, NICB, 460 Park Ave., New York, N. Y.

The fifth Hot Laboratories and Equipment Conference, covering the construction and management of laboratories for atomic research, March 14–15, is sponsored by the Hot Laboratories Committee. Chairman of the fifth session is Frank Ring, Jr., Oak Ridge National Laboratory, Oak Ridge, Tenn.

The International Atomic Exposition, March 11–15, is sponsored by AIChE, in co-operation with AIEE, ASME, ASCE, and

Ohio Valley Section New Officers



H. H. KERR, AIEE District 11 vice-president, visited the Ohio Valley Section for installation of officers on September 6. Among those present were (*left to right*) R. D. Crippen, secretary-treasurer; E. N. McDaniel, membership committee chairman; Mr. Kerr; W. R. Wagner, chairman; and F. R. Willoughby, vice-chairman.

AIME. Exposition director is J. V. Friel; exhibits manager is H. F. Grebe. Exposition offices are at 304 Architects Building, Philadelphia 3, Pa.

New Officers Introduced at Philadelphia Section Meeting

The Philadelphia Section of AIEE inaugurated the 1956–57 season at its October Main Section meeting with a talk by A. G. Dean, assistant chief engineer of the Budd Company of Philadelphia, Pa. Mr. Dean's subject "Lightweight Trains" covered the development of the various types of modern stainless-steel passenger cars, including the Santa Fe hi-level cars; Pennsylvania Railroad tubular train, "The Keystone"; New Haven high speed self-propelled cars; and the lightweight "Pioneer III" experimental car. T. E. Stieber, Westinghouse Electric Corporation, the senior past chairman of the Philadelphia Section, introduced the new officers: M. J. A. Dugan, General Cable Corporation, chairman; B. H. Zacherle, United Engineers and Constructors, vice-chairman; G. B. Schleicher, Philadelphia Electric Company, secretary; and R. S. Hewett, Minneapolis-Honeywell Regulator Company, treasurer.

Constantine Bary, who was recently elected a Fellow of the Institute, was presented his Fellow diploma by N. E. Funk, retired vice-president of the Philadelphia Electric Company and a former national president of the AIEE. Mr. Bary at present is the economic analysis engineer of the Philadelphia Electric Company.

L. R. Gaty, vice-president-research and development, of the Philadelphia Electric Company and a past chairman of the Philadelphia Section AIEE, was the speaker at the November Main Section meeting which was held jointly with The American Society of Mechanical Engineers. Mr. Gaty spoke on "Power Progress in Europe." He covered progress in generating plants (including the utilization of atomic energy), substation equipment, transmission lines, and other interesting items as observed during his recent trip through Europe and attendance at the World Power Conference in Vienna, Austria, the International Conference on Large Electric High-Tension Systems (CIGRE) meeting in Paris, France, and the International Electrotechnical Commission meeting in Munich, Germany.

The December meeting will feature a a talk by Peter Freeman of the Glenn L. Martin Company on "The Earth Satellite Project."

Michigan Section Holds Dinner Meeting

Members and guests of the Michigan Section of the AIEE heard Mitchell Kress and William Bingham of the financial analysis and rates department of the Cleveland Electric Illuminating Company give a talk on "Some Problems of Public Utility Rate Regulation in Today's Economy." The talk was given at a dinner meeting held on October 9, 1956, at the Arbor Hills Country Club in Jackson, Mich.

Mr. Kress pointed out that since the end of World War II privately owned electric utilities have spent over $23.5 billion and will probably spend over $10 billion more over the next three years. And, in order to continue to attract into the industry the huge sums of money necessary to finance this expansion, the prospect of earnings must be sufficient to attract and hold this capital. He also pointed out that the purpose of Government regulatory commissions is to substitute in public utilities the functions that direct competition performs in industry, and that when regulation goes beyond this it is poor regulation. He went on to say that two of the most important problems facing the industry are the determination of rate levels and getting them into effect; and that to do this, competent employees from every phase of the utility business should be educated in the field of rate regulation since they are the ones who must prepare the bulk of the material for any rate proceedings.

Mr. Bingham stated that the rate base has been cut down by both ignoring the effects of inflation and by unrealistic methods of handling depreciation costs. He said that a current value rate base or reproduction cost recognizes the parallel economic factors under which unregulated industry must operate, no matter which phase the business cycle may be in. Thus, reproduction cost puts utility owners on the same earnings basis as competitive enterprise. He went on to say that reproduction cost sticks strictly to the original purpose of,

C. W. BARY (*left*), economic analysis engineer of the Philadelphia Electric Company, was presented his Fellow diploma by N. E. Funk (*right*), retired vice-president of the Philadelphia Electric Company and a former national president of the AIEE, during a Philadelphia Section meeting.

Franklin Foto Studio

AMONG THOSE PRESENT at the Michigan Section dinner meeting were: (*seated, left to right*) H. M. Hess, Section secretary-treasurer; F. Von Voigtlander, Section chairman; Speakers B. Bingham and M. Kress of the Cleveland Electric Illuminating Company; E. H. Kaiser, Section Program Committee; (*standing, left to right*) J. J. Owens, Section Contact Committee; A. J. Hoffmeister, Section Entertainment Committee; J. W. Eakins, Section vice-chairman; and J. H. Foote, Great Lakes District chairman.

and justification for, regulation by limiting regulation to those factors whose benefits might otherwise be lost by eliminating competition. In addition, the responsibility of utilities is to shape rate regulation into proper channels where the sound application of the economic principles of the American system will result in equity for both the investor and the consumer.

J. H. Foote, chairman of the Great Lakes District, gave the invocation preceding the dinner. A brief business meeting was presided over by F. Von Voigtlander, chairman of the Michigan Section, during which he stressed the need for continued adult education in which the AIEE plays an important part.

E. H. Kaiser, who was in charge of the program, introduced the speakers. A. J. Hoffmeister of the Entertainment Committee and J. J. Owens of the Contact Committee assisted with the arrangements.

ECPD Issues 24th Annual Report

Engineers' Council for Professional Development (ECPD) has issued its 24th Annual Report for the year ending September 30, 1956. In "Retrospect and Prospect," which is the president's report to ECPD, Thorndike Saville discusses Committee Reports, Appointments to ECPD, EUSEC Conference on Engineering Education and Training, ECPD-Engineers Joint Council (EJC) Affiliation, and Survey of the Engineering Profession.

The main body of the Annual Report is made up of reports by the following committees: Guidance Committee, Education and Accreditation Committee, Student Development Committee, Training Committee, Recognition Committee, Ethics Committee, Information Committee, ECPD-EJC Joint Committee on Practice of Engineering, and ECPD-EJC Joint Task Committee on Engineering Profession Survey.

In the appendix: A Proposal for a Survey of the Engineering Profession, it is stated that "Critical problems have arisen in every facet of the profession: education, utilization of manpower, organization, and social and economic factors, all of which intimately concern the national welfare. It therefore seems appropriate, necessary, and, in fact, urgent that the engineering profession at this time make the first searching and comprehensive self study in its history." The scope and uses of the survey are then discussed.

Also included are reports of the representatives of the constituent organizations: AIEE, American Society of Civil Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Mechanical Engineers, The Engineering Institute of Canada, American Society for Engineering Education, American Institute of Chemical Engineers, and National Council of State Boards of Engineering Examiners.

Annual Report Issued by Engineering Societies Library

In the Annual Report of the Director of the Engineering Societies Library (ESL), given by R. H. Phelps, it was stated that the number of persons using the ESL increased again this year—the increase being 7 per cent. Over 75,000 photoprints were supplied to users. This is 15 per cent more than the previous year. Such increased use of the Library in a year in which one-third of the staff resigned made this a difficult year for continuing staff members.

Unlike most libraries, the ESL can be used without even going to the Library. Over one half of the 43,000 persons who used the ESL during the year were served by mail, telephone, and telegraph. Most orders for photoprint and microfilm copies of articles, for bibliographies, book loans, literature searches, and translations are received by mail. Some statistics of library use follows:

Services	1954–55	1955–56
Photoprint orders	4,598	5,127
Photoprints	65,728	75,627
Microfilm orders	330	364
Bibliography orders	781	467
Searches and paid services	142	124
Translations	204	233
Words translated	425,156	356,906
Borrowers	1,357	1,262
Books loaned	1,753	1,646
Telephone inquiries	10,501	10,711
Written replies to inquiries	3,827	3,835
Visitors served	18,696	21,023
Nonvisitors served	21,740	22,123
TOTAL	40,436	43,146

Income from paid services supplied by the ESL has doubled in the last six years. Much of this may be due to increasing business and research activity, but some, doubtless, is due to continuing promotion of the ESL which has been emphasized during recent years.

It was found necessary to increase some service bureau rates. No changes had been made since 1948. Rates now are:

Searches:
$6 per hour—a $1 increase.

Translations:
German, French, Italian, and Spanish into English $1.50 per 100 words—no increase.
Russian, Dutch, Portuguese, and Swedish into English $2.25 per 100 words—a 25¢ increase.
Quotations on other languages are made on request.

Photoprints:
45¢ per print—a 5¢ increase. Now all photoprints are sent first-class mail.

Microfilms:
$1.50 for a copy of one article in one volume for each 40 pages or fraction thereof—formerly no limit on number of pages.

Book Loans:
Only members may borrow books. 50¢ per week or fraction of a week for each volume borrowed—no increase.

Continuous examination of lists of publications, book reviews, publishers' notices, and other listings of new publications is a necessary step in the maintenance of an excellent library collection. Careful selection of books, reports, and periodicals likely to be of value to users of the ESL, who are primarily graduate and practicing engineers, is a second

AIEE District Executive Meeting

THE DISTRICT EXECUTIVE MEETING of the AIEE was held in San Francisco, Calif., On October 12, 1956, to discuss the progress and future plans of the Eighth (Pacific) District. Among those present were (*left to right*) D. I. Cone; E. W. Morris, secretary; and Bradley Cozzens, vice-president.

step, and the third step is systematic and thorough classification, cataloging, and indexing so that the information in the publications can be readily found. All of the foregoing have been kept up to date.

Uncounted thousands of items were received, many obviously of no value. 4,132 items were kept: 2,029 volumes, 2,050 maps, and 53 searches. 2,387 pamphlets were also added to the Library, but as they were inserted in volumes already cataloged, they do not add to the total number of volumes. The items withdrawn from the Library were: 170 maps and 924 volumes. Net accessions as of September 30, 1956 were: 173,078 volumes, 19,349 maps, and 5,573 searches. The total was 198,000.

The statistics on periodicals follows:

Periodicals Received	1954–55	1955–56
Subscription	370	375
Exchange	291	292
Gift	765	772
TOTAL	1,426	1,439

The Library Staff prepared reviews of 563 books valued at $3,900. The books were received from publishers in many countries. From these reviews, editors of eight publications selected and published those reviews of interest to their readers. The publications using the Library's reviews are: *Civil Engineering*, *Electrical Engineering*, *Engineering Index*, *Journal of the Engineering Institute of Canada*, *Journal of Metals*, *Journal of Petroleum Technology*, *Mechanical Engineering*, and *Mining Engineering*. The Library also paid $2,165 for books that were not reviewed, and $5,114 for periodicals.

ESL Bibliography No. *11* entitled "Bibliography on Machinery Foundations" was issued—a revision of ESL Bibliography No. *5*.

The ESL received a set of records of the American Engineering Council. The records cover the 20 years of achievement of the Council which pioneered in joint activities in the engineering profession.

The Library's extensive holdings of periodicals were checked for record in the coming new edition of the "List of Periodicals Abstracted by Chemical Abstracts." This list, which has world-wide use, helps in the location of scientific and technical periodicals.

The Library's new periodical and serial titles were checked for record in "New Serial Titles" published by the Library of Congress.

The Director of the Library, R. H. Phelps, was elected vice-president of the Board of the *Engineering Index*.

The Engineering Societies Monographs Committee, of which the Director of the Library is chairman, considered three original manuscripts. One was rejected, one tentatively accepted, and one accepted and published. It is "Engineering Analysis; a Survey of Numerical Procedures" by S. H. Crandall. Royalties received by the Library since the Engineering Societies Monographs series started in 1931 amount to $13,389.43.

A very substantial increase in use of the paid services of the ESL has helped to cover increased costs but other increased revenue is needed. The formula for support of the ESL by the Founder Societies has not been changed since 1928. In view of various factors including increased dues for members of all Founder Societies a change in the formula would appear to be a proper as well as a necessary step.

DURING the San Francisco General Meeting (*left to right*) Harvey Skow, Prize Paper Committee chairman, presents prize paper awards to T. A. Bettersworth, first prize winner; R. S. Wilson, third prize winner; M. E. Harp and M. H. Kebby, second prize winners.

San Francisco Section Presents Prize Paper Awards

Winners of the annual prize paper contest of the San Francisco Section were chosen during the general meeting of the Section in October. The winning paper was "Economies of Var Supply in a Large Electric Power System" by T. A. Bettersworth, supervising electrical engineer, Pacific Gas and Electric Company. The first prize of $50 and certificate of award was presented by Harvey Skow, Prize Paper Committee chairman and Central Pacific engineering manager, Westinghouse Electric Corporation. The second prize of $30 for the joint paper "A 72-Channel Radio System for Toll Telephone Service" was awarded to M. E. Harp, manager of radio development, and M. H. Kebby, chief development engineer, both of Lenkurt Electric Company. The third prize of $20 for the paper "Electricity in the Cannery" was presented to R. S. Wilson, senior electrical engineer, California Packing Corporation. Certificates of award also were presented to the authors of the three top papers from a field of 17 submitted in the contest.

Eta Kappa Nu Announces Outstanding Young Engineer Award

On October 20, 1956, the Jury of Award of Eta Kappa Nu met and selected J. J. Baruch of Boston, Mass., as winner of the Eta Kappa Nu Outstanding Young Engineer Award for 1956. Honorable mention was awarded to R. B. Seidel (AM '49) of Wayne, Pa.

Members of the Jury who selected the winner were N. S. Hibshman, secretary of AIEE, past president of Eta Kappa Nu; J. E. Hobson, former director of Stanford Research Institute, past president of Eta Kappa Nu; S. R. Warren, assistant vice-president of the University of Pennsylvania, past president of Eta Kappa Nu; K. B. Mac Eachron, dean of engineering, Case Institute of Technology; M. D. Hooven, electrical engineer, Public Service Electric and Gas Company of N. J., past president of AIEE, chairman of the Jury of Award; and J. W. Mac Rae, president, Sandia Corporation, past president of Institute of Radio Engineers.

Dr. Baruch, a graduate of Massachusetts Institute of Technology (MIT), is vice-president and director of the New Products Division, Bolt Beranek and Newman, Inc., a consulting firm of Cambridge, Mass. He is also associated with MIT in a part-time teaching capacity.

This year's Outstanding Young Engineer was born in Brooklyn, N. Y., August 21, 1923. He entered Brooklyn College in 1940. Before enlisting in the Signal Corps at the age of 19, he was a Civil Defense warden. Dr. Baruch served in both European and Pacific Theaters and received several decora-

J. J. Baruch

R. B. Seidel

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until December 31. Duplicate double-spaced typewritten copes of each discussion should be sent to Edward C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y., on or before December 31.

56-272 **Dynamic Core Behavior and Magnetic Amplifier Performance.** *L. A. Finzi, D. L. Critchlow*

56-970 **Design of Wide-Band Radio-Frequency Transformers Utilizing a Synthesized Equivalent Network.** *H. H. Kajihara*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

tions. He was involved in chemical warfare, explosives, and demolitions instruction and in carrier-radio operation.

In 1946, he began studies at MIT to major in electrical engineering (instrumentation). His master's thesis, "The Photoelastic Analysis of Dynamic Stresses," was conducted jointly under the mechanical and electrical engineering departments. He was awarded bachelor of science and master of science degrees simultaneously in June 1948. He received fellowships in acoustics for the years 1948–50 from Celotex Corporation and Armstrong Cork Corporation and completed his doctorate work with the thesis, "Instrumentation for Acoustic Transmission" at MIT. He served as assistant professor in electrical instrumentation at MIT until 1955.

He is a member of Hexalpha, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu, senior member of Institute of Radio Engineers, associate of American Institute of Management, and Fellow of Acoustical Society of America. Dr. Baruch has distinguished himself scientifically through the publication of many papers. He holds patents or has filed applications for nine devices and systems, principally in the field of acoustics.

Mr. Seidel, a Cornell man, holds the position of president of Automatic Temperature Control Company of Philadelphia, Pa.

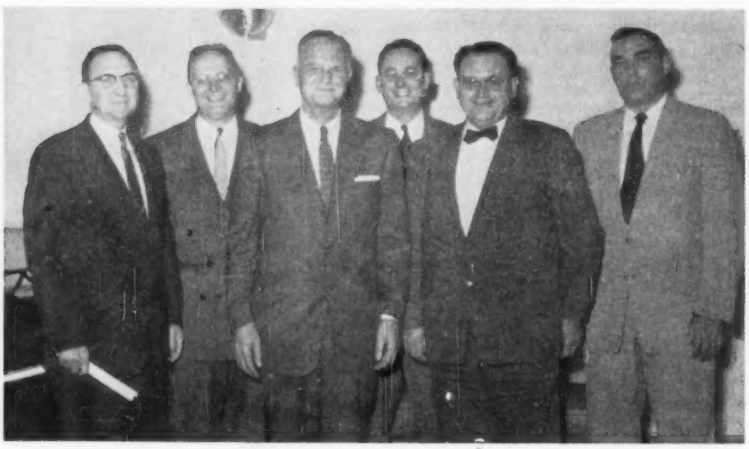
Mr. Seidel was born in Syracuse, N. Y., April 4, 1926. In 1943 he enlisted in the United States Navy and in 1944 he began his studies at Cornell. He was graduated in 1948 with an electrical engineering degree and immediately went to work as design and development engineer for the Lincoln Electric Company of Cleveland, Ohio.

He terminated his service with Lincoln Electric in 1954 to become chief engineer and director of research at Safety Car Heating and Lighting Company, New Haven, Conn. At about the same time, Mr. Seidel received his master of science degree in electrical engineering from Case Institute of Technology. The subject of his thesis was "A Theoretical Analysis of the Separately Excited A-C Motor," a first in its field. In 1954, Case Institute offered Mr. Seidel a full Fellowship for pursuit of a doctorate in electrical engineering but he was unable to accept. After undertaking a complete reorganization of the engineering and research departments at Safety Car Heating and Lighting, Mr. Seidel was transferred in 1955 to Automatic Temperature Control Company as vice-president and general manager. He has since been appointed president of that company.

Mr. Seidel is a member of Tau Beta Pi, Eta Kappa Nu, Sigma Xi, American Society of Mechanical Engineers, Instrument Society of America and holds professional engineer licenses in Ohio, Connecticut and Pennsylvania.

Dr. Baruch and Mr. Seidel will be honored at the Eta Kappa Nu Annual Award Dinner on January 21, 1957 during the AIEE Winter General Meeting New York, N. Y.

Pittsburgh Section Smoker



ONE OF THE GROUPS at the Kick-off Smoker of the Pittsburgh Section, held on September 27, 1956, at the University Club, included (*left to right*) W. H. Osterle, incoming Section chairman, who presided and introduced the Committee chairmen; L. J. Berberich, Section past chairman; C. T. Pearce, vice-president of District 2, who gave an outline of national and district Institute activities; W. R. Harris, Section secretary-treasurer; B. R. Teare, Jr.; and R. N. Wagner, Section vice-chairman, and chairman of the Program Committee, who described the technical meetings, inspection trips, and association affairs which had been arranged by the Program Committee. This year the organization meeting was combined with the smoker so that more of the members could become familiar with the technical and social program for the coming year, become better acquainted with each other, as well as meet officers and committee members of the Section.

Prices Advanced for IEE Journal and Proceedings

Further increases in the cost of printing and paper have necessitated an increase in the normal subscription rates for the *Journal* of The Institution of Electrical Engineers (IEE) and the three Parts, A, B, and C, of the *Proceedings*. Correspondingly, the specially reduced rates payable by AIEE members have had to be modified, and these, as from January 1, 1957, will be as follows:

Publication	Per Annum
Journal	17s. 6d.
Proceedings Part A (Power Engineering)	£1. 2s. 6d.
Part B (Radio and Electronic Engineering)	£1. 2s. 6d.
Part C (Monographs)	10s. 0d.
Journal and *Proceedings* Parts A, B, and C (combined subscription)	£3. 10s. 0d.

The specially reduced rates for "Science Abstracts" remain unchanged as follows:

Section A (Physics)	£3. 7s. 6d.
Section B (Electrical Engineering)	£2. 12s. 6d.
Sections A and B (combined subscription)	£5. 12s. 6d.

Notice of the new prices has been sent directly to AIEE members who are at present subscribing to these publications. New

orders should be sent to: N. S. Hibshman, Secretary, AIEE, 33 West 39th St., New York 18, N. Y., together with remittance for the appropriate subscription.

Engineers Meet in Mexico for Fourth UPADI Convention

Almost 200 engineers from 16 countries were officially registered at the Fourth Convention of the Union Pan-Americana de Asociaciones de Ingenieros (UPADI), which was held in Mexico City, Mexico, October 8–12. Host for the meeting was la Union Mexicana de Asociaciones de Ingenieros. President M. A. Mantilla, of the Mexican unit, was also President of the Convention. Meetings were held at Centro SCOP, the beautiful new building which houses the Secretaria de Comunicaciones y Obras Publicas (SCOP). Officers of the Convention were: President M. A. Mantilla, Mexico; Vice-President Adolph Ackerman, United States; Vice-President Saturnino de Brito, filho, Brazil; Vice-President Harry Tippenhauer, Haiti; Secretary E. M. Vega, Mexico; Secretary Galo Yepez, Ecuador; Secretary J. I. Planas, Cuba; Secretary Tate Erwin, Canada; and Secretary Alirio Cornejo, El Salvador.

The Convention was organized on Monday, October 8, and was formally opened that evening by the President of the Republic of Mexico, don Adolfo Ruiz Cortines. Preceding the President's remarks, J. M. Todd, chairman of the Engineers Joint Council (EJC) delegation, addressed the Convention on behalf of UPADI President, Luis Giannattasio, and Gail Hathaway, chairman of the EJC Committee on International Relations, greeted the Convention on behalf of the North American engineering societies. Convention committees met during the week to draft the various resolutions which were offered to the Convention on the final day of the meeting.

The Convention considered 33 resolutions, defeated one for the establishment of a Pan-American Institute of Electricity, tabled another on budget and passed the rest. The Convention urged that formal sessions on engineering education be held simultaneously with future conventions of UPADI, that scholarships be made available to engineers to study in other countries, that technical institutes be established for technicians and foremen. It suggested the compilation of a dictionary of common engineering terms and requested close co-operation with the Pan American Committee on Technical Standards. The need for creating national standards organizations was particularly noted. The United States and Canadian delegations were invited to secure the adoption of the metric system in their respective countries. Last, engineers were asked to study means of increasing productivity and participating in productivity centers wherever they exist.

Among the other actions taken by the delegates were the election of Uruguay, Panama, and Ecuador to the Board of Directors. Montevideo, Uruguay, was once again selected as the site of the UPADI headquarters; and Montreal, Canada, was chosen for the 1958 Convention.

The program of the Convention included two round tables which proved to be the highlight of the meeting and attracted many of the delegates. At the round table on atomic energy, Dr. Clark Goodman, of the U. S. Atomic Energy Commission, reaffirmed the policy of the United States to share its knowledge of the peaceful applications of atomic energy with the Latin American nations. The United States is assisting in the manufacture of nuclear reactors and is making research facilities available to Latin American scientists. A number of Latin American countries have signed agreements with the United States on nuclear research and three new ones are currently being negotiated. The Convention urged the Western Hemisphere nations to draw up uniform legislations on atomic energy and to provide for complete exchange of information on raw materials availability and resources. It asked for a report at the next convention on progress in the search for mineral deposits, production figures, and the uses of radioactive isotopes in agriculture, industry, biology, and medicine.

The round table on engineering education was conducted by Dr. L. H. Johnson, dean of the School of Engineering, Tulane University, New Orleans, La., and featured the remarks of Dr. Ralph Morgen, of the Purdue Research Foundation, Lafayette, Ind. The engineers who assisted in this round table developed five general areas of agreement on which future activity in this field could be based. They were: (1) there is great need in engineering schools to employ full-time professors at attractive salaries; (2) development of engineering education is the joint responsibility of industry and government; (3) there is need for a study of basic requirements in engineering curricula and facilities; (4) the next UPADI Convention should include a program for engineering educators; and (5) a permanent UPADI Committee on Engineering Education should be formed to function between conventions.

In the closing ceremonies of the Fourth Convention, the United States delegation paid honor to three Latin American engineers in acknowledgment of their contributions to UPADI. Wrist watches provided by the Hamilton Watch Company were presented to: Luis Giannattasio, president of UPADI, by Joseph Barker, president of The American Society of Mechanical Engineers; M. A. Mantilla, president of UMAI, by Gail Hathaway, chairman of the EJC Committee on International Relations; and Luis Giorgi, United States Alternate on the Board of Directors in Montevideo, by J. M. Todd, vice-president of UPADI.

M. D. Hooven Named New President of ECPD

M. D. Hooven, of Montclair, N. J., former president of the AIEE, was elected president of the Engineers' Council for Professional Development (ECPD) at the 24th annual ECPD Meeting in the Engineering Society of Detroit Building.

The ECPD is the recognized accrediting body for engineering curricula throughout the country.

Industrial Electronics Symposium Speaker

GEN. B. W. CHIDLAW (*left*), former U.S. Air Defense Chief, was luncheon speaker at the Fifth Annual Industrial Electronics Symposium held in Cleveland, Ohio, September 24–25. Introduced by the Program Chairman, Bob Rodgers (*right*), Gen. Chidlaw spoke on the subject "Electronics in Air Defense and Air Offense." Gen. Chidlaw, who is a retired Air Force general, was until May 1955 Commanding General of the Continental Air Defense Command and, thus, was responsible for the defense of the United States against enemy air attack. Gen. Chidlaw pioneered the development of the first U. S. jet airplane—the P-59. The meeting was sponsored by AIEE and Institute of Radio Engineers (IRE) and the IRE Professional Groups on Industrial Electronics and Production Techniques. Attendance at the two-day meeting was nearly 250. There were 16 papers presented which dealt with such topics as electronic equipment design; automatic production of electronic equipment; electronic testing, gauging, and process control; and electronic data reduction and analysis.

Mr. Hooven, an engineering executive with the Public Service Electric and Gas Company, Newark, N. J., has been active in the affairs of ECPD for many years. He served as the 1955–56 president of AIEE and is now serving on the Board of Directors as junior past president.

A 1920 graduate of Bucknell University, with a bachelor of science degree, magna cum laude, Mr. Hooven was an engineer for Westinghouse Electric and Manufacturing Company (now Westinghouse Electric Corporation) until he joined Public Service in 1922.

Reliability and Quality Control Symposium To Be Held in January

The Third National Symposium on Reliability and Quality Control in Electronics has announced its program and speakers list. Over 1,000 people are expected to attend the three day Symposium held at the Hotel Statler, Washington, D. C., January 14–16, 1957.

The First Symposium was held in New York, N. Y., November 12–13, 1954 at the Hotel Statler. This was a combined effort led by Mr. Bass of the Professional Group on Reliability and Quality Control (PGRQC) and the Electronic Division of the American Society for Quality Control (ASQC). Over 300 people were in attendance for the 4 sessions and 16 papers. The success of this Symposium encouraged the PGRQC and the Electronics Division of ASQC to sponsor another Symposium.

The Second Symposium was held in Washington, D. C., January 9–10, 1956. J. W. Greer of the Navy Department headed the Symposium which is now sponsored by the PGRQC of the Institute of Radio Engineers (IRE), the Electronics Division of ASQC, the Radio-Electronic-Television Manufacturers Association (RETMA) Staff Committee on Quality Acceptance Practices, and the AIEE. The response to the Second Symposium was overwhelming. More than 700 people attended 7 sessions and heard 18 papers.

A new inovation is being used for the first time this year. It is the mailing to advanced registrants material, papers, and definitions covering the three panel discussions. It is hoped that audience participation will be increased when they have had time to study the proposals.

More complete information can be secured by contacting R. M. Jacobs at Radio Corporation of America, Camden, N. J. Facilities are limited to 1,500 so come early and learn Reliability.

The tentative program for the Symposium follows.

Monday January 14

Keynote Address

"Review and Prediction in Reliability," J. M. Bridges

Session 2A Mathematical and Advanced Theory

Papers by:
L. Weinberg, Hughes Aircraft Company
T. L. Burnett, International Business Machines Corporation (IBM)
Prof. Epstein, Wayne University
G. R. Herd, Aeronautical Radio

Session 2B Principles for Design and Management of Reliability Programs

Papers by:
R. Kuehn, IBM
Dr. R. Weller, NAMTC
E. G. D. Paterson, Bell Telephone Company
L. J. Paddison, Sandia Corporation

Session 3A Trends in Airborne Equipment Reliability

Panel sponsored by Aircraft Industries Association

Session 3B System Reliability Analysis

Panel sponsored by RETMA System Reliability Committee

Session 4 Environmental Factors in Reliability of Electronic Equipment

Film from NEL

Session 5A Quality Acceptance Practices

Sponsored by RETMA Quality Acceptance Practice Committee
Papers by:
L. J. Jacobson, International Resistance Company
M. A. Acheson, Sylvania
G. Bowler, Hughes Aircraft
W. Kauffman, RCA
A. Warsher, Bendix Aviation

Session 5B Reliability Reports from AGREE, AGET, and OASD

Presented by:
W. I. Sumerlin, Philco
Dr. D. Wagner, Burroughs Corporation
E. A. Bender, OASD
M. Landis, AGET

Tuesday, January 15

Session 6A Commercial Electronic Reliability

Papers by:
A. A. McDonald, Motorola
W. A. MacCrehan, Bendix Radio
R. Lukens, Philco
J. Johnson, IBM
B. Van Swearingen, IBM
A. Hull, United Airlines

Session 6B Reliability of Component Parts

Papers by:
I. K. Munsen, RCA
W. Lamphier, Sprague Electric
H. S. Herrick, Erie Resistor
D. S. Gilbert, WCRE-WADC
R. J. Milliron, WCREG-WADC

Session 7A Quality Control in Production

Sponsored by ASQC with papers by:
S. J. Callabro, Federal Telephone and Radio
D. Shainin, Rath and Strong
D. A. Hill, H. D. Voegtlen, and R. H. Meyers, Hughes Aircraft
R. M. Jacobs, RCA

Session 7B Techniques for Reliable Design

Papers by:
G. Neuschaefer, USN
J. R. Smith, NEL
J. Muncy, Bureau of Standards
G. T. Ross, RCA
C. J. Moore, NAESU

Banquet

Address: D. E. Noble, vice-president of Motorola, Inc.

Session 8 Basic Definitions in Reliability

A Panel and floor discussion

Wednesday, January 16

Session 9 and 10 Inspection Tours

Naval Ordnance Laboratory
Andrews Air Force Base
David Taylor Model Basin
(Citizenship required)

Chase Ltd., Photo

SOME COMMITTEE MEMBERS for the Third National Symposium on Reliability and Quality Control in Electronics are (*standing, left to right*) R. M. Jacobs, Radio Corporation of America, publicity chairman; R. G. Murrell, Melpar, Inc., registration chairman; J. E. Culbertson, Western Electric Company, facilities cochairman; J. W. Greer, U. S. Navy Bureau of Ships, general cochairman; I. W. Schoeninger, Centralab, Globe Union, facilities chairman; (*seated, left to right*) M. E. King, U. S. Navy Bureau of Ordnance, finances chairman; A. B. Mundel, Sonotone Corporation, chairman: sponsor Electronics Division, American Society for Quality Control; M. M. Tall, Radio Corporation of America, general chairman; and Dr. Victor Wouk, Beta Electric Division, Sorrenson and Company, chairman: sponsor Professional Group on Reliability and Quality Control of the Institute of Radio Engineers.

Additional Conference Papers Are Now Available

The following is the list of conference papers presented at the 1956 Fall General Meeting, Chicago, Ill., October 1-5, which were not numbered at the time of the meeting. They have now been numbered and are available to members for 40¢, and to nonmembers for 80¢. Send order and remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

CP56-1039 A Comparison of Tests for Selenium Rectifiers. *D. A. Klotzfer*
1018 Selenium Rectifiers and Their Aging Characteristics. *C. E. Brigham*
103 Design Fundamentals of Diesel-Electric Locomotive Control Systems. *A. V. Johansson*
1045 Development of Wiring Diagram Standards for Land Transportation Vehicles. *C. W. Martin, H. S. Ogden*
1020 Dry Batteries in Emergency Equipment. *R. C. Clock*
1026 Experiences in the Termination of Aluminum Wire and Cable in Industrial and Commercial Applications. *Henry Esch*
1059 Voltage Drop Calculations for A-C Power Distribution Systems. *R. T. Morgan*
1015 Closed Circuit Color TV at Walter Reed Hospital. *L. E. Anderson*
1051 Television Allocation Trends. *O. W. B. Reed, Jr.*
1030 Modern Constant Voltage Chargers. *W. D. Fletcher*
1050 Grid Alloys and Battery Characteristics. *F. J. Port*
1036 Some Charge Characteristics of Lead Acid Batteries. *E. A. Hoxie*
1022 Transmission of Newspapers by Facsimile Over a Wide-Band Channel. *A. G. Cooley, J. R. Shonnard*
1048 Predicting Performances of Large Power Shovels. *L. A. Moucha, M. A. Neslin*
1037 Lower Operating Costs through Statistical Analysis of Motor Failures. *J. M. Jenkins*
1056 Automatic A-C Mine Hoist at Trotter Coal Company. *W. E. Thomas*
1054 Some Studies of Visual Perception Speed. *G. C. Sziklai*
1044 Sound Power Measurements on AIEE Noise-Test Motor by Different Laboratories. *A. F. Lukens*
1027 Noise Reduction in Electrical Machinery for Shipboard Installation. *Samuel Feldman*
1043 Reduction of Motor Noise in the Field. *R. H. Lee, Vaughn Hill*
1055 Committee Report on Current Status of Load-Frequency Control Methods and Equipment by the System Controls Subcommittee of System Engineering. Presented by C. N. Metcalf
1042 Class H Insulation for Heavy-Duty D-C Motors. *F. C. Kreitler*
1019 Silicone Insulation in Mining Machine Motors. *J. A. Buss, F. R. Hugus*
1017 Rewinding Electrical Equipment with Silicone Class H Insulation. *R. L. Bogardus*
1029 Problems in Standardizing per Unit Quantities. *R. M. Fisher, Jr.*
1034 A Proposed NSPE Brochure on Rules of Professional Conduct for Engineers. *O. H. Hall*
1033 A Frequency Converting Telephone Carrier Repeater for Military Use. *G. Goltsos, J. H. Johnston, R. B. Anderson*
1016 Maintenance Problems and Considerations in the Independent Telephone Industry. *B. L. Arnold*
1057 Manufacturer's Program for Equipment Maintenance. *G. D. Wallenstein*
1028 Tests of Excitation System Transient Performance. *R. W. Ferguson, T. J. Bliss*
1023 Defining Excitation System Response. *H. W. Cory, W. F. Eagan*
1040 An Improved Method of Phase Failure Protection. *W. Kniel*
1046 The Influence of Airborne Particles on the Radio and Corona Characteristics of Smooth Conductors. *C. J. Miller, Jr.*
1035 Over-all Aspects of Telegraph Maintenance. *R. Hoover*
1031 Transmission and Reliability Maintenance of Type TD2 Radio Relay Systems. *E. T. Fruhner, R. D. Service*
1058 Importance of Fringe Tests in Vacuum Tube Maintenance. *D. S. Wise.*

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

COMMITTEE ACTIVITIES

EDITOR'S NOTE: *This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

Communication Division

Committee on Radio Communications Systems (R. D. Campbell, *Chairman;* David Talley, *Vice-Chairman;* P. T. Sproul, *Secretary*). The Committee on Radio Communications Systems has been considering ways and means of improving attendance at the technical sessions it sponsors in conjunction with the General Meetings of the Institute. Discussion of this problem has led to a plan of appointing a Committee member to assume responsibility for arrangements for each meeting in co-operation with the regular Committee officers. It is hoped that improvement of program arrangements and more direct efforts in stimulating interest among the members will result in increased attendance at these meetings.

The Committee also believes that efforts to obtain more papers on engineering projects of current popular interest would tend to stimulate attendance. Frequently, papers of this sort overlap the fields of two or more Committees and it proves desirable to arrange for jointly sponsored meetings or meetings sponsored by the Communications Division. The meetings held at Chicago, Ill., on Communication Maintenance are a good example of the success which co-operative efforts of this sort can achieve.

Arrangements along this line are now being made in co-operation with the Committee on Data Communication and the Committee on Science and Electronics for a series of papers on communications with the earth satellite to be presented at the Winter General Meeting of the Institute in New York, N. Y., January 1957.

Industry Division

Committee on Electric Heating (W. C. Rudd, *Chairman;* F. T. Chesnut, *Vice-Chairman;* E. J. Bates, *Secretary*). The Electric Heating Committee is now preparing to hold a two-day conference on Electric Heating in Toledo, Ohio, in April of 1957. The conference will cover furnace, salt bath, infrared, induction, dielectric, and metal sheath heating. It is also planned to hold several open forums for discussions at the conference.

The Subcommittee on Induction and Dielectric Heating has been co-operating with the Federal Communications Commission in making various tests and submitting recommendations on radio interference from high-frequency heating equipment. These tests and recommendations are to assist the Federal Communications Commission in the writing of the new rules and regulations on such equipment.

The Committee work covered studies of radio interference measurements, r-f feedback on power lines, deterioration of shielded rooms, and interference cases from various types of equipment.

The Data Subcommittee is in the process of assembling data and writing a manual giving much general information on electric heating. The manual will give much of the basic information required to design and operate electric heating processes. It is expected to be a publication of the AIEE.

Committee on Mining and Metal Industry (R. B. Moore, *Chairman;* F. R. Hugus, *Vice-Chairman*). During the year 1956, the Metal Industries Subcommittee of the Committee on Mining and Metal Industry was active in the fields of electric power distribution in steel plants and in electric systems for automatically controlling thickness on steel strip on tandem cold reduction mills. Three technical sessions were held at the Summer and Pacific General Meeting, San Francisco, Calif.

Papers were developed and presented dealing with distribution practices generally, and the problem of fluctuating loads both from the viewpoint of the steel plant as a user and the electric utility as a supplier of electric power. The problems of interconnection where the steel plant generates power and where fluctuating loads are supplied were also considered.

The trend toward automation and the increasing use of automatic control systems in the steel industry was analyzed. Significant contributions to the art were made by technical papers reporting on extensive analyses of the problems of automatic gage control on tandem cold reduction mills. The analyses presented went beyond anything existing in the literature covering both the steady state and the transient conditions existing when the thickness of steel strip is being automatically regulated in the five stands of a tandem cold reduction mill.

Work is being done in the preparation of technical papers pertaining to application of electric equipment in arc furnace systems. Papers will cover analytical background as well as application rules and suggested practices. The new area of static switching systems will be looked into by the Subcommittee.

Instrumentation Division

Committee on Special Instruments and Auxiliary Apparatus (Harry Sohon, *Chair-*

man; E. B. Curdts, *Vice-Chairman;* C. Stansbury, *Secretary*). The Subcommittee on High Voltage Measurements is concerned with definitions and practices in high voltage techniques. Its chairman, J. H. Hagenguth, has been asked to be adviser to the United States on International Electrotechnical Commission, Technical Committee No. 42: High Voltage Testing.

The Subcommittee on Dielectric Measurements has completed a Recommended Guide for Making Dielectric Measurements in the Field, which has been approved by the Standard Committee on a trial basis. It is expected that this guide will be procurable from headquarters in the latter part of 1956.

The Subcommittee on Rotary Speed Measurements is preparing a code covering techniques and apparatus suitable for such measurements. In this activity the Subcommittee will have the co-operation of liaison with the Committee on Rotating Machinery.

Power Division

Committee on Power System Communications (L. G. Eaton, *Chairman;* G. E. Farmer, *Vice-Chairman, East;* L. E. Ludekens, *Vice-Chairman, West;* J. L. Evans, *Secretary*). The Technical Operations Department has approved the request of the Committee on Carrier Current to change its name and scope. The name is now "Committee on Power System Communications," and the scope now is:

> "Treatment of all matters in which the dominant factors are the design, construction, and operation of equipment and circuit for the application of carrier to provide systems for the control of the production, transmission, and distribution of power.
> "Also treatment of all matters in which the dominant factors are the requirements, selection, installation, and operation of beamed radio systems (microwave) to provide similar systems of control.
> "Included in the scope of this Committee shall be treatment of the following: carrier equipment (including line traps and coupling capacitors) and circuits for communications as applied to power system use, including: Relaying—Control—Metering, also Beamed radio systems for similar applications."

With the increased interest and use of "microwave" for power system communications the new name and scope more adequately describe the functions of this committee.

The Power Division has recently approved a new subcommittee of the Committee on Power System Communications. The subcommittee title is Subcommittee on Equipment Design Standards. Its scope is:

> ". . . to formulate standards for power system communications equipment design such as dielectric test voltages, ratings, conditions of operation, etc., similar to those already established for relays associated with power apparatus—ASA *C37.1;* and Automatic station control, supervisory and telemetering equipments—*C37.2.*"

It is expected that this new Subcommittee will begin active work in the near future.

Committee on System Engineering (R. T. Purdy, *Chairman;* C. N. Metcalf, *Vice-Chairman;* A. P. Fugill, *Secretary*). The activities of the Committee on System Engineering over the past few years have been centered on the development of computation and control equipment for the economic loading of generating stations, the simplification of the necessary transmission loss formulas for use with this equipment, and the probabilities involved in the calculation of system reserves. A study is presently being implemented by a working group under the System Controls Subcommittee on the application of incremental heat rates for load scheduling and for automatic load-frequency control.

Several Subcommittee reports, involving considerable work, have recently been completed. The first of these, on the "Current Status of Load-Frequency Control Methods and Equipment," was presented at the Fall General Meeting in Chicago, Ill. Two others are scheduled for presentation at the 1957 Winter General Meeting in New York, N. Y. These are "Guide for Application of Arc Furnaces on Power Systems," and "Forced Outage Rates of High-Pressure Steam Turbines and Boilers."

The attendance at two technical sessions on Application of Computing Devices to System Engineering Problems, held at the Fall General Meeting in Chicago, Ill., fully justified the joint efforts of the Computer Application Subcommittee of System Engineering, and the Committee on Computing Devices in developing this program. A special publication of the papers presented at those sessions, together with a summary of the discussion which ensued is planned.

It is hoped that for the 1957 Summer General Meeting a full session on probabilities involved in calculating system reserves can be presented.

Committee on Transmission and Distribution (T. J. Brosnan, *Chairman;* I. B. Johnson, *Vice-Chairman;* J. T. Lusignan, Jr., *Secretary*). The last meeting of the Committee on Transmission and Distribution, held in Cincinnati, Ohio, on August 23, 1956, was combined on the following day with a most interesting inspection trip to the Clifty Creek generating and switching station of the Ohio Valley Electric Corporation (OVEC) near Madison, Ind. At a luncheon in the Clifty Creek Inn, brief discussions of the station and its function were given by members of the OVEC staff. Also distributed were copies of the OVEC booklet "Power for Peace." An inspection of the station and switchyard followed the luncheon.

The Clifty Creek station has a steam generating capacity of 1,29 million kw. Its primary purpose is to supply power to the Atomic Energy Commission's Portsmouth project over the 330,000 volt OVEC transmission lines.

Current activities of the Capacitor; Distribution; General Systems; Lightning and Insulator; and Towers, Poles, and Conductors Subcommittees may be summarized by the following project titles of these subcommittees: Capacitor Bibliography, Capacitor Standards, Capacitor Volt Time Characteristics, Capacitor Switching, and Capacitor Technical Papers; High Voltage Distribution, Grounding of 480 Volt Secondary Systems, Higher Secondary Voltages, and Protection of Distribution Circuits; Switching Surges, Fault Location Methods, Arc Deionization Times, and Corona and Radio Influence-High Voltage Transmission Lines; and Impulse Characteristics of Insulators, Wood and Air in Series, Fundamental Basis for the Insulation of Transmission Lines, Status of Basic Impulse Insulation Standardization, Use of Silicones or other Oils or Waxes on Insulator Surfaces for Operation in Contaminated Areas, Abnormal Frequency of Flashover of High Voltage Lines, and Lightning Protection of Aerial Cables.

Of the foregoing projects further comments are in order on the subject "Abnormal Frequency of Flashover of High Voltage Lines." At technical sessions of recent AIEE meetings, papers have been presented on the problems that have received much discussion, indicating an industry-wide interest. The interest in the lightning performance of overhead transmission lines is focused on lines of twin circuit design using one ground wire. The interest tends to increase with increased voltage levels since there appears to be no improvement in outage performance notwithstanding the appreciable increase in insulation levels of the higher voltage lines. For the extra high voltage lines, design calculations based on accepted methods of estimating performance had indicated that they should be essentially "lightningproof." Experience proved otherwise. Experience at the lower voltage levels also seems to indicate a much better performance with two ground wires over the use of one ground wire. Why? The question remains unanswered—positively. As a consequence the question has stimulated investigation in the field, in the laboratory, and analytically, on factors of insulation, lightning phenomena, and the mechanism and manner of calculating the lightning flashover of the line insulation.

A new feature has been added to the meetings of the Committee. This might be called its "closing hour" devoted to "What's New in T. and D." The feature calls for presentations and discussions of topics to and by the Committee members. These discussions have covered such subjects as the Rural Electrification Administration program for long-range planning of its distribution system, a new concept in planning high voltage secondary systems, use of aluminum on towers, lightning experience on a specific transmission line, design features of extra high voltage transmission lines, forthcoming high altitude and high voltage tests to be conducted on the question of corona and radio influence from transmission lines, and reports on the activities abroad in the field of transmission and distribution.

Science and Electronics Division

Committee on Magnetic Amplifiers (H. W. Lord, *Chairman;* A. B. Haines, *Vice-Chairman;* R. W. Roberts, *Secretary*). The first Special Technical Conference on Magnetic Amplifiers, held in Syracuse, N.Y., April 5–6, 1956 was an outstanding success. Interest in the papers presented ran high and a vote from the floor indicated an overwhelming majority in favor of a similar conference in 1957.

In view of this success, a second Special Technical Conference is being planned. It will be held in Pittsburgh, Pa., September 4–6, 1957 at the Penn-Sheraton Hotel. The technical program will consist of four sessions with an invited paper heading each session. Those wishing to submit papers for

presentation at this conference are urged to contact the Technical Program Chairman, G. F. Pittman, for further details. It is planned that all papers presented will be reviewed and approved in advance. Also planned for the conference is a manufacturers exhibit of magnetic amplifiers, components, and associated products.

Committee on Metallic Rectifiers (D. E. Trucksess, *Chairman;* E. A. Harty, *Vice-Chairman;* L. W. Burton, *Secretary*). During the AIEE Fall Meeting in Chicago, Ill., and with the approval of the Science and Electronics Committee, the name of this committee has been changed to: "Semiconductor—Metallic Rectifier Committee" in accordance with a recommendation brought back from the International Electrotechnical Commission Meeting in London, England, by the U.S. Delegates to Committee 22-2. A revision of the scope of the Committee was also made and approved which is as follows:

> "Treatment of all matters in which the dominant factors are extended surface semiconductor rectifiers for the rectification and control of a-c power including their applications. If the field of application of such devices falls within the scope of other technical committees, action with these committees may be joint."

During the Committee meeting held October 9, 1956, plans were formulated to handle the combined Conference on Rectifiers to be held in Chicago, Ill., in May 1957, in collaboration with the Power Conversion Committee. Glen Ramsey, assisted by D. Borst, was appointed to co-ordinate activities for this Committee. I. K. Hedding has announced that over 10 technical papers are already available for this conference.

The Committee plans to meet again during the Winter Meeting, but no paper meeting will be scheduled at this time.

AIEE PERSONALITIES

W. G. Amey (AM '47, M '54), supervisory research engineer, Leeds and Northrup Company, Philadelphia, Pa., has been promoted to division chief of the Electromechanical Division in the research and development department. Dr. Amey received his bachelor and doctorate of engineering from The Johns Hopkins University. He joined Leeds and Northrup in 1947, as a research technologist. Among his more recent work has been participation in the development of the production model of the firm's new Type *K-3* Universal Potentiometer. He has served four years in the naval reserve, in connection with Naval Research Laboratory work and instruction at the U. S. Naval Academy. He has also held teaching posts in the evening high school of the Baltimore Polytechnic Institute and The Johns Hopkins University. Dr. Amey is a member of Tau Beta Pi and Sigma Xi honorary fraternities, and of the Physics Club of Philadelphia. He has published several papers in the technical press. Dr. Amey has served on the AIEE Basic Sciences Committee (1953–56).

Theodore Braaten (AM '22, M '31), general manager of the City of Norwich department of public utilities, Norwich, Conn., has been elected president of the Connecticut Society of Professional Engineers for the year 1956–57. Mr. Braaten came to Norwich in 1946 from the Boston (Mass.) Edison Company where he was assistant head of the Station Electrical Design Division. He was with the Westinghouse Electric Corporation for 12 years as switchboard engineer at East Pittsburgh, Pa., and central station engineer in the Boston, Mass., office. During World War II, he served in the European Theater as a member of "Cisler's Circus," a group of utility specialists who directed the restoration of utilities. He is a past chairman of the Connecticut Section of AIEE, and has served on the AIEE Committee on Electrical Machinery (1941–47).

Walter Evan-Jones (AM '46), assistant sales supervisor, Commercial Radio Communications Equipment, Commercial Products Division, Canadian Marconi Company, Ltd., Montreal, Que., Canada, has been appointed Central and Western Ontario sales representative for electronic products, facilities, and services of Measurement Engineering, Ltd., Arnprior, Ont., Canada. Mr. Evan-Jones has been associated with the Hydro Electric Power Commission of Ontario, Communications Engineering Group, and the Canadian Westinghouse Company, Ltd., in the capacity of sales supervisor, mobile radio communication equipment. He has been actively engaged in the commercial radio and electronics fields for the past 15 years and has served as a specialist in broadcast, electronics and communication equipment sales. Mr. Evan-Jones will be responsible for the district sales office activities which are now being established in Burlington, Ont., and will be in charge of the sales promotion in the Central and Western Ontario territory. He is a member of the Institute of Radio Engineers.

G. R. Mezger (AM '37), general sales manager of the Technical Products Division of Allen B. Du Mont Laboratories, Inc., Clifton, N. J., has been appointed vice-president of the Measurements Corporation, Boonton, N. J. Administration and expansion of sales of the corporation's line of precise electronic laboratory equipment will be Mr. Mezger's primary responsibilities. At Du Mont, he was responsible for the sale of television transmitter and studio equipment, mobile communications equipment, and electronic test equipment. He also served that company, at various times, as assistant division manager, sales manager, and as chief engineer. During World War II, Mr. Mezger participated in instrument development work at the U. S. Navy David W. Taylor Model Basin and, later, in the development of radar equipment. He retired in the U. S. Naval Reserve with the rank of Commander. He is a senior member of the Institute of Radio Engineers. Mr. Mezger has served on the AIEE Publication Committee (1951–55).

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

OBITUARIES

Walter Atwood Hall (AM '03, M '03, F '12, Member for Life), retired electrical engineer, died September 19. Mr. Hall was born in Wallingford, Conn., January 7, 1874. He received a bachelor of arts degree from Harvard University and a bachelor of science degree in electrical engineering from the Massachusetts Institute of Technology. For over 23 years he was connected with the General Electric Company in Lynn and Pittsfield, Mass. Later he maintained his own office as consulting engineer in Boston, Mass., for 18 years. For the next 10 years before his retirement in 1948, he was employed as an engineer by the Reconstruction Finance Corporation (RFC). Mr. Hall was a former vice-president of AIEE and a Fellow of The American Society of Mechanical Engineers. He served on the following AIEE Committees: Edison Medal (1919–21); Executive (1919–20, 1921–22); Finance (1917–20); Industrial and Domestic Power (1914–15); Membership (1914–16, chairman 1915–16); and Sections (1914–15, 1916–21, chairman 1916–20).

Juan Clemente de la Rosa (AM '15, M '40, Member for Life), superintendent of electrical maintenance and construction for the Toronto Transit Commission, Toronto, Ont., Canada, died recently. Mr. De la Rosa was born June 24, 1891, in Caracas, Venezuela. He studied at the Queen's Royal College in Trinidad, B.W.I., and later at the Technical Institute in London, England, and graduated in 1912. From 1915 to 1916, he was assistant engineer for the Caracas and Venezuelan Railway. During World War I, he served with distinction in the British Expeditionary Forces. After being discharged from the armed forces in 1919, he settled with his family in Toronto, Ont., Canada and entered the service of the Toronto Street Railway

Company as a repairman, working on electric motors. In 1922, he was promoted to foreman in charge of this work. The Toronto Transportation Commission was established in 1921 and took over the Toronto Street Railway Company. In 1928, Mr. De la Rosa's duties were extended and he was made responsible for maintenance and supervision of substations. He became superintendent of substation maintenance in 1937, and electrical superintendent in charge of maintenance for substations and overhead systems in 1946. He was promoted to the position of superintendent of electrical maintenance and construction in 1954. He was a member of the Association of Professional Engineers of Ontario, the Illuminating Engineering Society, and the Royal Arch Masons. Mr. De la Rosa had been vice-chairman of the AIEE Toronto Section for the year 1956–57, and chairman of its Program Committee.

George Wellington Hamilton (AM '19, F '29, Member for Life), consulting engineer, died recently at the age of 76. Mr. Hamilton was born in Pottsville, Pa., November 26, 1879. Between the years 1900 to 1912, he was employed in various capacities by the Stanley Electrical Manufacturing Company; Pittsfield Works of the General Electric Company, Pittsfield, Mass.; the New York, New Haven and Hartford Railroad Company and Subsidiary, Connecticut Company, New Haven, Conn.; and the Rockland Light and Power Company of New York, Nyack, N. Y.; and Rockland Electric Company of New Jersey, Nyack, N. Y. From 1912 to 1919, he served as vice-president in charge of construction and operation of electrical properties throughout central and southern Illinois for the Central Illinois Public Service Company, Mattoon, Ill. In 1919, he became vice-president in charge of hydraulic and electrical engineering for Middle West Utilities Company, Chicago, Ill. From 1946 to 1947, he served as chief engineer with the Division of Power, Department of the Interior, Washington, D. C. Following this, he became a hydroelectric consulting engineer. Mr. Hamilton was a life member of the American Society of Civil Engineers and a member of the Western Society of Engineers. He was a registered professional hydroelectrical engineer in the District of Columbia and the State of Illinois.

Paul Baily (AM '15, M '51, Member for Life), retired electrical engineer, formerly employed by the Ohio Power Company, died recently at the age of 68. Mr. Baily was born in Atlantic City, N. J., August 7, 1887. He graduated from Bliss School of Electrical Engineering of Tacoma Park, Washington, D. C., in 1914. He began his association with the American Gas and Electric Company in Atlantic City in 1916 and was a member of the Veteran Employees' association of the Western Division. He joined the Ohio Power Company in 1919. Mr. Baily was a member of the Ohio Society of Professional Engineers and National Society of Professional Engineers. He was very active in church work and many civic projects, serving on the board of the Tiffin, Ohio, YMCA for several years. He was also a member of the city traffic control committee.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of October 18, 1956, recommended the following applications for transfer. Any objections to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Abou-Hussein, M.S., senior lecturer, engineering faculty, University of Cairo, Giza, Egypt
Ashe, M. A., electrical contractor, 6617 N. 20th St., Philadelphia, Pa.
Ashton, T., project engineer, Lincoln Electric Co., Cleveland, Ohio
Behm, F. F., electrical engineer, Gilbert Associates, Inc., Reading, Pa.
Black, W. S., communications engineer, American Tel. & Tel. Co., Philadelphia, Pa.
Blanton, H. E., engineer, Hycon Eastern, Inc., Cambridge, Mass.
Conner, E. E., design engineer, Westinghouse Electric Corp., Sharon, Pa.
D'Esopo, F. P., manager, product engineering, The Wiremold Co., Hartford, Conn.
Earle, A. P., district superintendent, Shawinigan Water & Power Co., Trois Rivieres, Que., Can.
Elliott, C. L., general superintendent, Southern Indiana Gas & Electric Co., Evansville, Ind.
Fagin, S. L., principal electronics engineer, Emerson Research Laboratories, Washington, D. C.
Giles, W. F., Jr., engineer, Baltimore Gas & Electric Co., Baltimore, Md.
Gill, B. J., northwest district manager, Century Electric Co., Spokane, Wash.
Gudikunst, P. B., electrical engineer, Gilbert Associates, Inc., Reading, Pa.
Hulburt, H. T., electrical engineer, Pure Carbon Co., St. Marys, Pa.
Ironside, H. N., Sr., superintendent O. H. Lines, Pacific Gas & Electric Co., Stockton, Calif.
Jackson, S. P., manager, commercial equipment engineering, General Electric Co., Lynn, Mass.
Keck, L. E., section manager, Westinghouse Electric Corp., East Pittsburgh, Pa.
Kreydick, W., assistant electrical engineer, Metropolitan Sanitary District of Greater Chicago, Cicero, Ill.
Langdon, D. E., engineer, Gilbert Associates, Inc., Reading, Pa.
Lantz, A. D., Jr., development engineer, Ohio Brass Co., Barberton, Ohio
Larson, L. D., plant engineer, Inland Empire Paper Co., Millwood, Wash.
Manning, T. J., district manager, The Okonite Co., Cincinnati, Ohio
Markel, R. A., Jr., engineer, Philadelphia Electric Co., Philadelphia, Pa.
Markow, G. R., associate engineer, airborne computer lab., International Business Machines Corp., Endicott, N. Y.
Marshall, J. A., general manager, Wild Rice Electric Coop. Inc., Mahnomen, Minn.
Martin, C. A., senior electrical engineer, apparatus & optical div., Eastman Kodak Co., Rochester, N. Y.
McCloud, H. L., electrical engineer, Tennessee Valley Authority, Knoxville, Tenn.
McIntire, T. B., Jr., special supervisor, Allis Chalmers Mfg. Co., Pittsburgh, Pa.
McKinnon, W. H., assistant to executive assistant, Duke Power Co., Charlotte, N. C.
Meese, W. G., assistant director, engineering lab., Detroit Edison Co., Detroit, Mich.
Melvin, E. A., project engineer, Frederick Research Corp., Bethesda, Md.
Mills, B., vice-president, Lapp Insulator Co., Inc., Le Roy, N. Y.
Moll, D. E., methods engineer, Western Electric Co., Inc., New York, N. Y.
Mosquini, M. R., engineer, Southern California Edison Co., Los Angeles, Calif.
Muir, R. C., application engineer, General Electric Co., Schenectady, N. Y.
Murray, T. W., assistant engineer, Baltimore Gas & Electric Co., Baltimore, Md.
Niki, T., design engineer, General Electric Co., Philadelphia, Pa.
Norton, R. J., apparatus engineer, Line Material Co., Denver, Colo.
Olschner, P. Q., area sales manager, Westinghouse Electric Corp., St. Louis, Mo.
Ormsby, C. R., electrical engineer, Bonneville Power Administration, Portland, Ore.
Pearson, E. E., Test Engineer, Leeds & Northrup Co., Philadelphia, Pa.
Pratt, G. B., senior assistant electrical engineer, Public Lighting Commission, City of Detroit, Mich.
Pullan, J. S., electrical engineer, Board of Public Utilities, Jamestown, N. Y.
Pulliam, P. E., engineer, Goodyear Atomic Corp., Portsmouth, Ohio
Rohatyn, F. S., president, Queensboro Transformer & Machinery Corp., College Point, N. Y.
Rosenbarker, I. E., test associate engineer, International Business Machines Corp., Endicott, N. Y.
Sanchirico, A. J., project engineer, IBM Airborne Computer Lab., Vestal, N. Y.
Saven, N. I., district meter specialist, General Electric Co., Chicago, Ill.
Seidel, R. B., president, Automatic Temperature Control Co., Inc., Philadelphia, Pa.
Smith, W. P., partner, Smith & Sheen, C. E., Box 213, Watertown, S. D.
Sours, D. T., design engineer, Aero Div., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Spence, R. O., Senior distribution engineer, Alabama Power Co., Jasper, Ala.
Sreb, J. H., physicist, U. S. Department of Defense, Washington, D. C.
Stringer, L. F., senior engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Swayambu, S. I., deputy power chief, planning commission, New Delhi, India.
Thompson, A. T., professor of engineering research, Pennsylvania State University, University Park, Pa.
Travis, H., president, Travis Electric Co., Nashville, Tenn.
Tseng, A. A., electrical engineer, Vern E. Alden Co., Chicago, Ill.
Ungemach, C. D., supervising engineer, Mountain States Tel. & Tel. Co., Helena, Mont.
Unnewehr, L. E., engineer, The Franklin Institute, Philadelphia, Pa.
Warmoth, H. W., assistant general manager, Sacramento Municipal Utility District, Sacramento, Calif.
Warne, C. C., Jr., vice-pres. & genl. mgr., Hubbard Aluminum Products Co., Pittsburgh, Pa.
Weiss, O. W., distribution project engineer, Union Electric Co., St. Louis, Mo.
Wells, C. H., engineer, Public Service Co. of Colorado, Denver, Colo.
Whisler, H. L., plant engineer, Carborundum Co., Vancouver, Wash.
Wieting, J. H., electrical engineer, Carbide & Carbon Chemicals Co., Port Lavaca, Tex.
Wilson, F. J., chief industrial engineer, A. M. F. Cycle Co., Little Rock, Ark.
Wintter, J. E., designer, Southern Services, Inc., Birmingham, Ala.
Wolff, G. M., development engineer, General Electric Co., Schenectady, N. Y.

70 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership, in the grade of Member have been received from the following candidates, and any member objecting to election should so notify the Secretary before December 25, 1956 or February 25, 1957, if the applicant resides outside of the United States, Canada or Mexico.

To Grade of Member

Archer, R. S., chief electrical engineer, United Kingdom Oil Mills Executive, Unilever Limited, London, England
Congleton, R. T. (re-election), assistant manager, Application Engineering, Master Electric Co., Dayton, Ohio
David, J. R., vice-president & general sales manager, Gearhart Co., Atlanta, Ga.
Douglas, A., senior development engineer, Ericsson Telephones Ltd., Beeston, Nottingham, England.
Dunn, G. B., Jr., manager-General Purpose Motor Engineering, General Electric Co., Fort Wayne, Ind.
Durnovo, C. P., engineer, International Standard Electric Corp., New York, N. Y.
Fagan, M. E., Jr., engineering manager, Transformer Div., Westinghouse Electric Corporation, Sharon, Pa.
Fredrickson, C. O., chief electrician (e.e.), Corn Products Ref. Co., Argo, Ill.
Jacobson, R., group engineer, Radioplane Co., Van Nuys, Calif.
Jenkins, W. D., engineering supervisor, Westinghouse Electric Corp., Atlanta, Ga.
Jennings, J. E., president, Jennings Radio Mfg. Corp., San Jose, Calif.
Kauffman, V. C., manager-engineering, large lamp dept., Lamp Div., General Electric Company, Cleveland, Ohio
Lasseter, J. A., system distribution engineer, Florida Power & Light Co., Miami, Fla.
Monro, A. J., chief electrical engineer, Mid-Lachlan County Council, New South Wales, Australia
Peters, E. G., electrical engineer, Washington Water Power Company, Spokane, Wash.
Ponzer, J. L., division power engineer, Carolina Power & Light Co., Southern Pines, N. C.
Ralph, E. E., applications engineer, Columbia Electric & Mfg. Co., Spokane, Wash.
Ralston, G., fellow engineer, Westinghouse Electric Corporation, Baltimore, Md.
Reeves, B. E., division supt., Southwestern Gas & Electric Co., Mt. Pleasant, Tex.
Seifert, R. L., manager, Installation & Service Engineering-Electrical, General Electric Company, Chattanooga, Tenn.
Sorensen, R. J., Electronic Systems Division engineer, Lockheed Aircraft Corp., Marietta, Ga.
Stevens, L. J. (Re-election), manager-Advance Engineering, General Electric Company, Baltimore, Md.
Taylor, O. L., manager of engineering, Bryant Electric Co., Bridgeport, Conn.
Treon, C., senior project engineer, Duquesne Light Company, Pittsburgh, Pa.
Warfel, G. H., communications engineer, Bank of America, San Francisco, Calif.

25 to grade of Member

AIEE Section and Student Branch Meetings 1955-56

Table I. Section Membership, August 1956; Section Meetings During Year Ending April 30, 1956

Section	AIEE Members August 1956	Number of Meetings	Total Number of Meetings
Akron	233	4	4
Alabama	324	9	9
Arizona	278	9	
Groups: Technical		3	
Electronics and Communications		7	
Industrial and Mining		2	
Power		7	28
Arkansas	162	10	
Group: Technical		7	
Subsection: Northwest Arkansas		9	26
Arrowhead	82	9	9
Baton Rouge	84	8	8
Beaumont	121	11	
Subsection: Lake Charles		6	
Joint Meetings: Beaumont Section and Lake Charles Subsection		1	18
Boston	1,103	8	
Group: Technical		17	27
Canton	122	8	
Groups: Management Discussion		4	
Power		1	13
Central Illinois	201	9	
Group: Technical		8	17
Central Indiana	381	9	9
Chicago	2,175	7	
Groups: Basic Science		3	
Communications		4	
Electronics		6	
Industrial		5	
Power		5	30
Cincinnati	400	13	13
Cleveland	1,072	9	
Groups: Basic Science		4	
Electrical Construction		5	
Electronics, Communication, and Instrumentation		4	
Management		5	
Motors and Control		4	
Power Generation and Distribution		5	36
Columbus	290	11	
Subsections: Chillicothe		6	
Zanesville		12	
Joint Meetings: Columbus Section and Chillicothe Subsection		1	30
Connecticut	820	8	
Groups: Communications		3	
Electric Power Generation Transmission and Distribution		4	
Electrical Controls and Measurements		3	
Industrial Electronics		2	
Industrial Power Applications Management		2	25
Corpus Christi	108	13	13
Dayton	350	8	
Groups: Aeronautical		2	
Electronics Discussion		3	
Motors and Control Discussion		1	
Power Discussion		2	
Joint Meetings: Power, Dayton Section and Power Discussion		1	
Dayton Section and Motors and Control		1	18
Delaware Bay	177	13	
Group: Discussion		2	15
Denver	480	10	
Groups: Communications and Electronics Technical		5	
Electrical Equipment		5	
Power Systems		4	
Subsections: Black Hills		5	
Southern Colorado		1	
Joint Meetings: Power Systems and Electrical Equipment		1	31
East Tennessee	422	18	
Groups: Chattanooga Technical		6	
Knoxville Technical		4	
Subsections: Huntsville		11	
Muscle Shoals		7	
Tullahoma		8	54
El Paso	142	12	12
Erie	224	14	14
Fort Wayne	231	5	5
Georgia	355	12	12
Hamilton	202	4	4
Hawaiian	96	12	12
Houston	372	9	
Groups: Communications		1	
Industrial Applications		5	
Radio Communications		2	
Power		2	
Subsection: Freeport		4	
Joint Meetings: Power and Industrial Application		1	24
Illinois Valley	83	10	
Group: Technical		9	19
Iowa	109	10	
Subsection: Northwest Iowa		4	14
Iowa-Illinois	101	8	8
Ithaca	353	8	
Groups: Technical Discussion		4	
Binghamton Area Technical Discussion		5	
Subsection: Binghamton Area		9	26
Jacksonville	111	9	9
Johnstown	70	11	11
Kansas City	425	13	
Groups: Communications		1	
Power		5	19
Lehigh Valley	480	10	
Group: Technical Discussion		26	36
Lima	102	6	
Groups: Aeronautical		3	
Motors and Control		3	12
Los Angeles	2,480	8	
Groups: Aircraft		5	
Basic Sciences		6	
Communications		5	
Construction Design		5	
Electronics		6	
Industrial		6	
Magnetics		3	
Power		7	
Young Engineers		9	
Subsections: Boulder City		9	
Riverside-San Bernardino		8	
Joint Meetings: Electronics and Management		1	
Communication and Electronics		1	78
Louisville	220	12	
Subsections: Lexington		8	
Paducah		2	22
Lynn	309	19	
Subsection: Maine		1	20
Madison	126	9	9
Maine	83	5	5
Mansfield	122	8	8
Maryland	893	9	
Groups: Aircraft		7	
Communications		3	
Industrial Electronics		3	
Power		3	
Subsection: Eastern Shore		8	33
Memphis	136	10	10
Mexico	191	9	9
Miami	207	11	11
Michigan	1,074	7	
Groups: Communications		3	
Industry		3	
Educational		1	
Management		2	
Power		4	
Science and Electronics		4	24
Milwaukee	992	8	
Groups: Basic Science Discussion		4	
Electrical Machinery Discussion		3	
Electronics Discussion		3	
Power Application and Control		2	
Transmission and Distribution		4	
Subsections: Fox River Valley		7	
Racine-Kenosha		1	
Joint Meetings: Milwaukee Section and Fox River Valley and Racine-Kenosha		1	33
Minnesota	476	10	
Subsection: Red River Valley		9	9
Mississippi	99	9	9
Mobile-Pensacola	116	12	12
Montana	113	5	
Subsection: Billings		7	
Joint Meetings: Section and Billings subsection		1	13
Montreal	492	14	
Subsection: Quebec		4	18
Nashville	111	8	8
Nebraska	219	10	10
New Hampshire	144	11	11
New Orleans	246	9	9
New York	5,954	2	
Groups: Basic Science		3	
Communication		8	
Illumination		5	
Power and Industrial		14	
Transportation		4	
Subsections: Hudson Valley Division		5	
New Jersey Division		13	
Joint Meetings: Basic Science and Communications Division		1	55
Niagara Frontier	365	8	8
Niagara International	159	15	15
North Carolina	470	2	
Subsections: Charlotte		9	
Eastern North Carolina		9	
Mid-State		9	
Western North Carolina		8	37
Northeastern Michigan	119	13	13
Northern New Mexico	201	16	
Subsection: Los Alamos-Sante Fe		5	21
North Texas	650	9	
Groups: Aircraft		2	
Communications		2	
Distribution Practice		2	
Subsections: Central Texas		4	
Fort Worth		5	
West Central Texas		8	32
Oak Ridge	76	9	9
Ohio Valley	95	15	
Subsection: Scioto Valley		8	23
Oklahoma City	213	9	
Groups: Electronics-Communications		3	
Industrial Practices		3	
Power Systems		7	24
Ottawa	96	12	12
Panhandle Plains	156	11	
Group: Technical		10	21
Philadelphia	2,004	9	
Groups: Communications Discussion		3	
Power and Applications		9	
Science and Electronics		12	
Subsection: Atlantic City Division		7	
Joint Meetings: Instruments and Measurement and Electronics		1	
Philadelphia Section and Communications		1	42
Pittsburgh	1,511	10	
Groups: Communications		2	
Industrial		7	
Power Generation		3	
Science and Electronics		3	
Transmission and Distribution		2	
Subsection: Centre County		6	33
Pittsfield	361	17	
Subsection: Vermont		7	24
Portland	539	16	
Subsections: Eugene		8	
Medford		7	31
Providence	214	9	
Group: Electronics		3	12
Richland	111	17	17
Ridgway	63	9	9
Rochester	283	18	18
Rock River Valley	128	8	8
Sacramento	159	10	
Groups: Design and Construction		4	
Electronics		5	
Power Generation		5	
Transmission and Distribution		5	29
St. Louis	771	11	
Groups: Industrial Apparatus		7	
Power Practices		7	
Subsection: Eastern Division		6	
Joint Meetings: Power Practices and Industrial Apparatus		2	33
St. Maurice Valley	54	9	9
San Diego	203	11	
Groups: Aviation Technical		11	
Electronics Technical		7	
Industrial		8	
Management		6	
Utility Technical		8	51

Sections	AIEE Members August 1956	Number of Meetings	Total Number of Meetings
San Francisco	1,553	28	
Groups: Industry		3	
Power		7	
Subsections: Fresno		9	
Reno		9	
San Jose		7	
Shasta		7	
Joint Meetings: San Francisco Section and San Jose Subsection		1	71
Savannah	54	7	7
Schenectady	1,013	11	
Subsection: Adirondack		7	18
Seattle	785	9	
Groups: Aircraft		10	
Basic Science		4	
Management		2	
Power		4	
Transportation		1	
Subsection: Tacoma		6	
Joint Meetings: Seattle Section and Tacoma Subsection		1	
Seattle Section and Management Technical		1	38
Sharon	237	9	9
Shreveport	168	10	
Groups: Communications and Electronics		2	
Industrial Practices		1	
Transmission and Distribution		2	
Subsection: Monroe		9	24
South Bend	130	12	12
South Carolina	240	4	
Subsection: Central Savannah River		7	
Charleston		8	
Columbia		9	
Piedmont		9	
Joint Meetings: Charleston and Columbia Subsection and South Carolina		1	38
South Texas	142	9	9
Spokane	190	11	
Group: Nuclear Power for Electric Generation		6	
Subsection: Wenatchee		8	
Joint Meetings: Spokane Section and Wenatchee Subsection and Richland Section		1	26
Springfield	134	9	
Group: Technical		4	13
Susquehanna	274	7	7
Syracuse	431	9	
Subsection: St. Lawrence International		6	15
Tampa	212	5	5
Toledo	186	11	
Groups: Industrial Practices		3	
Power		4	18
Toronto	739	15	
Groups: Communications		3	
Discussion		11	
Joint Meetings: Toronto Section and Communications Technical		1	
Toronto and Communications Technical		1	
Toronto Section and Discussion		1	32
Tulsa	206	9	
Group: Technical		18	27
Utah	177	6	
Subsections: Boise		6	
Eastern Idaho		3	15
Vancouver	331	10	
Group: Discussion		8	
Subsection: Vancouver Island		10	28
Virginia	306	2	
Subsections: Hampton Roads		8	
Richmond		5	
Joint Meetings: Virginia Section and Hampton Subsection		1	16
Virginia Mountain	182	8	8
Washington	1,050	9	
Group: Technical		5	14
West Michigan	130	8	8
West Virginia	116	11	
Groups: Electronics and Communications		2	
Power and Distribution		3	16
Wichita	143	14	14
Worcester	119	9	9
	45,893		2,114

Total Sections, 109
Total Technical groups, 125
Total Subsections, 58

Table II. Branch Meetings Held During Year Ending April 30, 1956

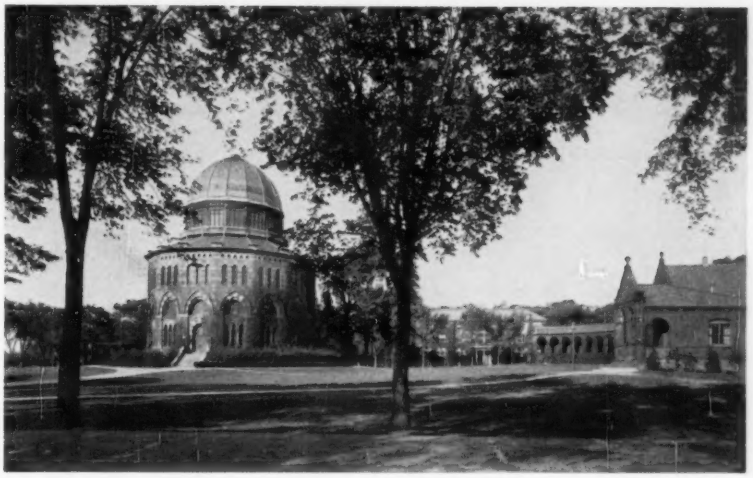
Branch	Number of Meetings
*Akron, University of	7
Alabama Polytechnic Institute	12
Alabama, University of	12
*Alberta, University of	7
*Arizona, University of	9
*Arkansas, University of	2
†Bradford Durfee Technology Institute	
*British Columbia, University of	20
Brooklyn, Polytechnic Institute of	
*Day Division	13
*Evening Division	5
*Brown University	2
*Bucknell University	8
†Buffalo, University of	
*California, University of	20
*California Institute of Technology	3
†California State Polytechnic College	1
*Carnegie Institute of Technology	11
Case Institute of Technology	7
Catholic University of America	4
*Cincinnati, University of	4
*Clarkson College of Technology	6
*Clemson A & M College	11
*Colorado A & M College	9
*Colorado, University of	10
*Columbia University	9
*Connecticut, University of	4
*Cooper Union	9
*Cornell University	6
*Dayton, University of	20
*Delaware, University of	10
*Denver, University of	12
*Detroit, University of	8
*Drexel Institute of Technology	7
*Duke University	7
Fenn College	7
*Florida, University of	15
†Gannon College	9
*George Washington University	6
Georgia Institute of Technology	6
†Houston, University of	5
Howard University	8
Idaho, University of	21
Illinois Institute of Technology	12
*Illinois, University of	7
Chicago Division	17
*Iowa State College	10
Iowa, University of	20
*Johns Hopkins University	16
Kansas State College	14
*Kansas, University of	4
Kentucky, University of	8
*Lafayette College	8
†Lamar State College of Technology	13
Laval University	1
Lehigh University	7
Louisiana Polytechnic Institute	8
*Louisiana State University	16
*Louisville, University of	11
*Maine, University of	9
*Manhattan College	10
*Marquette University	9
*Maryland, University of	4
*Massachusetts Institute of Technology	5
*Massachusetts, University of	7
*Michigan College of M & T	13
*Michigan State University	10
*Michigan, University of	5
Milwaukee School of Engineering	10
Mississippi State College	12
*Minnesota, University of	8
*Missouri School of Mines and Metallurgy	7
*Missouri, University of	10
*Montana State College	9
*Nebraska, University of	9
*Nevada, University of	9
Newark College of Engineering	7
†New Bedford Institute of Textiles Technology	5
*New Hampshire, University of	10
*New Mexico College of A & M Arts	3
*New Mexico, University of	3
*New York, College of the City of	25
New York University	
*Day Division	25
*Evening Division	6
*North Carolina State College	11
*North Dakota State College	9
*North Dakota, University of	7
*Northeastern University	12
*Northwestern University	29
*Norwich University	7
*Notre Dame, University of	11
Ohio Northern University	4
*Ohio State University	11
*Ohio University	10
*Oklahoma A & M College	10
*Oklahoma, University of	10
Oregon State College	12
*Pennsylvania State University	12
*Pennsylvania, University of	14
Pittsburgh, University of	17
*Pratt Institute	14
*Princeton University	4
Puerto Rico, University of	5
*Purdue University	6
*Rensselaer Polytechnic Institute	7
*Rhode Island, University of	
*Rice Institute	5
*Rose Polytechnic Institute	7
*Rutgers University	9
*St. Louis University	5
Santa Clara, University of	5
†Seattle University	
*South Carolina, University of	8
South Dakota State College	14
South Dakota School of Mines & Technology	6
*Southern California, University of	19
*Southern Methodist University	9
*Stanford University	8
*Stevens Institute of Technology	3
Swarthmore College	7
*Syracuse, University of	5
*Tennessee, University of	6
†Tennessee Polytechnic Institute	14
Texas College of Arts & Industries	8
*A & M College of Texas	7
*Texas Technological College	8
*Texas, University of	8
Texas Western College Sub-Branch	8
*Toledo, University of	11
*Toronto, University of	7
*Tufts College	7
*Tulane University	6
Union College	7
United States Naval Academy	2
United States Naval Postgraduate School	2
*Utah, University of	17
Vanderbilt University	12
Vermont, University of	6
Villanova College	7
Virginia Military Institute	10
*Virginia Polytechnic Institute	13
*Virginia, University of	8
*State College of Washington	13
*Washington University	3
*Washington, University of	23
*Wayne University	7
*West Virginia University	7
*Wisconsin, University of	6
*Worcester Polytechnic Institute	8
*Wyoming, University of	14
*Yale University	7
Youngstown University	8
	1,356

Total branches 149
*Joint AIEE-IRE Branches (115)
†Affiliate Branches (9)

ELECTRICAL ENGINEERING EDUCATION

AIEE in Union College

UNION COLLEGE was celebrating its centennial when an electrical engineering course was started in 1895. From 1902 to 1913, the illustrious Dr. C. P. Steinmetz headed the department and, until his death in 1923, he remained as Professor of Electrophysics. Union's was one of the first college radio stations in the 1920's and out of the Radio Club evolved the AIEE Student Branch, established in December 1934 with the help of the Schenectady (N. Y.) Section. Just after World War I, undergraduates began to hold electrical engineering shows. These have become annual Open House shows through which relatives, friends, and local high-school students have become acquainted with the College's progress in electrical engineering. Even with optional attendance at Branch meetings, more than half of the upperclassmen are Student Members.



Courtesy White Studio

RPI Plans for 80 Per Cent Increase in Undergraduate Enrollment

A PROGRAM which would make possible an increase in its undergraduate enrollment by 80 per cent and an increase in its classroom and laboratory buildings by 50 per cent is being planned by Rensselaer Polytechnic Institute (RPI).

Dr. L. W. Houston, president, indicated that the expansion would be under way in the near future. He said it was charted for completion during the next 14 years and characterized it as Rensselaer's obligation to provide its share of sorely needed engineers and scientists and to meet the educational needs of a college-age population that was increasing rapidly and that would reach a new peak during that period.

The 80 per cent jump in enrollment would mean about 2,450 more undergraduate students than are now in attendance. This would bring RPI's undergraduate enrollment to more than 5,200 students. Present undergraduate enrollment is about 3,000.

President Houston said the program would necessitate the acquisition of an additional $24.5 million in endowments, $8 million for the construction of new classroom and laboratory buildings, and the borrowing on a self-liquidating basis of several millions of dollars for the construction of additional living quarters for students.

Rensselaer is the oldest college of science and engineering in the country. Its engineering graduates rank second in number to the privately supported colleges and fifth to all engineering schools.

Dr. Houston stated that the present rate of endowment investments per student at RPI is $10,000. To maintain this ratio, with a student increase of 80 per cent, will require an additional $24.5 million of endowments. This is a sizable amount to raise even in 14 years, but nearly all privately endowed colleges have development programs under way and RPI's efforts of this nature are now averaging an increase in endowments of around $1 million a year. It appears that with increased efforts there is a reasonable chance of acquiring this amount.

Dr. Houston also pointed out that annual contributions for RPI's current operations has been increasing materially. If RPI continues to get its share from alumni and friends, corporations, and foundations, these gifts should also keep pace with such needs, he stated. The $8 million in contributions for academic facilities, would have to come from such sources.

The problem of additional living quarters for students, he pointed out, was one that could be more easily solved. The Federal Government has an extensive program of loans to colleges for this purpose and, under present rates charged on the loans, dormitories and dining halls could amortize themselves in 40 or 50 years. He said that borrowing for this purpose seems good business. Dormitories worth $3 million, accommodating 650 students have already been built with such loans.

At present, Rensselaer is engaged in an extensive study of teaching methods and techniques in the hope not only of improving its educational quality, but also of effecting substantial savings which would be devoted to higher salaries to the faculty.

The problem of teaching facilities—classrooms, laboratories, and equipment—has also received equally serious study with the result that it is believed that the best of facilities for a student body 80 per cent larger can be provided by increasing the physical facilities by only 50 per cent. This would be accomplished by more efficient and intensive use of present classroom and laboratory space.

Dr. Houston defined Rensselaer's stand on the question of expansion which has been the subject of some controversy among educators. Some have held that accepting a much larger number of students would impair the quality of their education.

"The leading engineering schools cannot lower their standards," he declared. "All of us are seeking quality. The real problem is not one of simply maintaining quality but of producing high-quality students in the quantity that industry must have. Bigness and quality are not mutually exclusive. If they were, many of our leading larger companies would have ceased growing long ago."

However, he warned that faculty and facilities—and funds to support them—will be of little avail unless there are adequate numbers of properly qualified high school graduates available to enter engineering colleges.

He continued by saying that one of the things that limits the number of engineers and scientists being graduated today is the failure of high school students to prepare properly. Many applicants might make the grade in engineering colleges with more preparation. Possibly it would take an extra semester or an extra year in high

school to determine whether they are qualified for an engineering education.

"We must start working on the students in their first and second years of high school," he stated. "We must give additional assistance to secondary schools in order to encourage more young people to buckle down and learn the necessary science and mathematics. On the college level, improved selection and counseling procedure and improved methods of instruction should decrease the number who drop out of engineering colleges."

Dr. Houston observed that with needed assistance forthcoming, it seemed reasonable to expect that by 1970 the colleges would award between 45,000 and 50,000 engineering degrees, an increase of 100 per cent in the number of graduating engineers.

"But to do so," he declared, "will require a broader understanding, especially on the part of businessmen and industry, of the problems which the colleges must solve. Educational progress is essential to industrial progress. The rate of that progress will be determined largely by the rate of co-operation. This requires bold planning, clear vision and, above all, prompt action."

University of Kansas Is Host to Tau Beta Pi National Convention

TAU BETA PI'S 51st National Convention was held at the University of Kansas, Lawrence, Kans., October 10–13, 1956. The Kansas Alpha chapter at the University of Kansas was official host, and all but three of the Association's 99 collegiate chapters were represented at the session. The convention was also attended by Tau Beta Pi's national officers head by President H. M. King, retired General Electric Company turbine engineer, of Swampscott, Mass.

The convention, with headquarters at Kansas University's Memorial Union, consisted of four business meetings, several specially arranged discussion periods, and a banquet program of particular interest. Arrangements for the national meeting were under the direction of J. C. Remsberg, president of the host chapter, and Dean T. D. Carr, head of the School of Engineering and Architecture at the University of Kansas. P. H. Robbins, executive director of the National Society of Professional Engineers, Washington, D. C., and Tau Beta Pi's director of Fellowships, served as chairman of the convention business meetings.

Following a pattern of long standing, a proposal to admit women to membership in Tau Beta Pi was again offered at the 1956 convention. The national meeting accepted the proposal for the third time in recent years, although its action is subject to ratification by the student members of the Association's 99 chapters. On the two previous occasions the proposal failed of ratification. If it should fail again, the chapters will still be empowered to award special Women's Badges to girls who meet the same scholarship and character qualifications required of men for membership. Over the past 22 years, 208 women have been so honored, by 62 different chapters.

The convention voted to hold the 1957 national meeting in October at the University of Wisconsin and Marquette University. A joint invitation from the Wisconsin Alpha and Beta chapters at those institutions was accepted, and next year's convention will meet first at the University of Wisconsin in Madison, then move to Milwaukee, Wis. for its last two days.

A major event of the convention at the University of Kansas was the initiation and banquet on Friday evening, October 12. The initiation ceremony was conducted by the Executive Council and officers of Tau Beta Pi for 22 students of Kansas University and for 10 prominent professional men including Herbert Hoover, Jr., Undersecretary of State of the United States, and K. A. Spencer, president of the Spencer Chemical Company, Kansas City, Mo. Both Mr. Hoover and Mr. Spencer delivered major addresses as part of the banquet program. Mr. Hoover spoke on "The Challenge of Engineering," with special reference to world affairs, and Mr. Spencer, directing his remarks to the students in his audience, told of the important part they must play as professional men in the years ahead.

Valuable features of Tau Beta Pi Conventions are the chapter-work discussions and the exhibits at which ideas for school and community service projects and chapter administration are exchanged by the delegates, most of whom are presidents of their local groups. This year's discussions in that field were again led by students under the general direction of Dr. M. E. Van Valkenburg of the University of Illinois, chapter co-ordinator for the Association.

Tau Beta Pi is a national engineering honor society which was founded at Lehigh University, Bethlehem, Pa., in 1885. It now has 99 undergraduate chapters in United States engineering colleges, 26 alumnus chapters, and over 88,000 initiated members. Students are elected to membership by the chapters from the top 20 per cent (scholastically) of their engineering classes on the basis of character and service to their colleges. Alumni may be elected on the basis of their eminent achievements in the engineering profession.

Tau Beta Pi's present Executive Council, or board of directors, includes five alumnus members who live in or near Boston, Mass. In addition to President King, the Council includes Vice-President W. C. Voss, consulting engineer and retired head of the building engineering and construction department at Massachusetts Institute of Technology; Dr. L. W. Bass, of the executive staff of A. D. Little, Inc.; Dr. C. F. Muckenhoupt, chief scientist of the First Naval District; and Dr. H. K. Brown, mathematical research specialist with the Avco Corporation.

AIEE-IRE Student Branch at Texas Tech Holds Initial Meeting

A record-breaking attendance marked the first meeting for the school year 1956–57 of the AIEE-Institute of Radio Engineers (IRE) Student Branch on the campus of Texas Technological College at Lubbock, Tex. The meeting, held October 1, began with a welcoming address to the 143 attending members by Chairman Ray Aylesworth senior electrical engineering student who will preside over the student organization for the school year. Next on the agenda was the introduction of the faculty advisors for the organization, Associate Professors of electrical engineering, T. B. Stenis and C. E. Houston, representing the national organizations of the AIEE and the IRE, respectively.

The officers for the new year introduced by Chairman Aylesworth were Bill Love, vice-chairman; Bill Thompson, treasurer; Adron Hall, AIEE Branch secretary; and Bill Flowers, AIEE Branch secretary.

After a short business session, the meeting was adjourned to a "get-acquainted" session of students and faculty members where refreshments were served.

The organization has 205 paid members at this time and, as evidenced by the large attendance at the initial meeting, interest is high. With many interesting programs planned, and a large active membership, the Texas Tech AIEE-IRE Student Branch anticipates a highly successful year.

New Award Established in Engineering Education

A major new award in engineering education, to recognize the research potential and accomplishment of young workers engaged in engineering research in a college or university, will be given for the first time in June 1957.

The Engineering College Research Council

of the American Society for Engineering Education has announced plans for the Curtis W. McGraw Research Award, established in memory of the late Curtis W. McGraw, president of the McGraw-Hill Publishing Company from February 1950 to September 1953, and brother of the present president, D. C. McGraw. The award, sponsored by the McGraw-Hill Book Company, will include a cash prize of $1,000 and will be given annually beginning June 1957.

Candidates are to be young men "...who have made original contributions in engineering research and who have demonstrated high potential for future leadership."

In announcing the new award, R. J. Woodrow of Princeton University, chairman of the Engineering College Research Council, pointed out that it is the second major award in engineering college research administered by the American Society for Engineering Education through the Council. The Vincent Bendix Research Award, for contributions to the development of research activities and their management, was first made last June to Dr. C. C. Furnas, chancellor of the University of Buffalo and Assistant Secretary of Defense for Research and Development.

Dr. Woodrow said that the development of these two awards serves to emphasize the growing importance of basic research as a part of engineering education. Both teachers and their students benefit from participation in active research undertakings on their campuses. This kind of research is the best assurance that today's engineering students will graduate well equipped to meet tomorrow's needs.

The recipient of the McGraw Research Award will be selected each year by a special committee of the Engineering College Research Council; Dean J. R. Cudworth of the University of Alabama is chairman of this year's selection committee.

The first presentation of the McGraw Research Award will be at the 1957 annual meeting of the American Society for Engineering Education, at Cornell University from June 17–21. Nominations for 1957 should reach Dean Cudworth by February 1, 1957.

Anderson, S. C., Student Awarded Westinghouse Scholarship

J. H. Jones, an electrical engineering senior from Anderson, S. C., has been awarded the $500 Westinghouse Achievement Scholarship at Clemson College for 1956–57.

The scholarship, provided by the Westinghouse Corporation, is based on an excellent academic record through the first semester of the junior year, leadership on campus and, partly, financial aid.

Mr. Jones has a grade point ratio of 3.6 out of a possible 4.0 at Clemson. He was elected to Phi Eta Sigma, honorary freshman fraternity, was treasurer of the junior class last year, and is 1956–57 president of Blue Key, Clemson leadership and service organization.

The scholarship was presented by Dr. J. S. Sams, dean of the school of engineering, at a joint branch meeting of the AIEE and Institute of Radio Engineers.

Fulton Sylphon To Award Three Engineering Scholarships

Four year scholarships to the University of Tennessee are being offered to three outstanding high school graduates by the Fulton Sylphon Division of Robertshaw-Fulton Controls Company. The total value of the scholarship program is $4,300 per year.

The company, in making the scholarships available, said it wishes to encourage students to enter the field of mechanical or electrical engineering. Winners are obligated to continue with the study of the mechanical or electrical engineering course for four years to qualify for the scholarship. They are under no obligation to accept employment with the company after graduation.

Similar scholarships will be awarded each year.

Two winners of the 1956 scholarships have been selected, with the third yet to be chosen by the University of Tennessee scholarship committee. Each will receive a $100 cash prize in addition to four years of tuition valued at $1,200. Continuation of the scholarship tuition depends on the winner's maintaining a good scholastic average in his four year study of engineering.

The Fulton Sylphon Division said that winners of the scholarships are selected on competitive basis. Two scholarships go to children of employees and the other to a graduate of a Knox County Senior High School.

To be eligible, a graduate must have completed high school in the the upper third of his class.

An Electrical Engineer in Manufacturing

J. C. LEBENS (AM '41, M '48), vice-president in charge of engineering, Bussmann Manufacturing Company, Division of McGraw Electric Company, St. Louis, Mo.

"AIEE furnishes the practicing engineer a professional environment in which he can grow. The young engineer can gain poise and perspective in the local and national activities of the Institute. By rubbing shoulders with other neophytes as well as with established engineers he can develop professionally and socially. Once established, the engineer can find in the Institute activities stimulation and interest for the continuation of his growth."

J. C. Lebens received his bachelor of science and master of science degrees in electrical engineering from Washington University. While at the University, he was elected to Tau Beta Pi, Sigma Xi, and Pi Mu Epsilon.

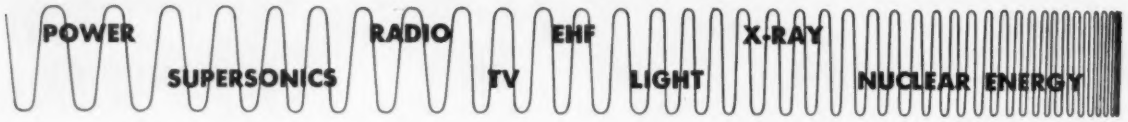
In 1935, Mr. Lebens was employed by the Bussmann Manufacturing Company as an electrical engineer. He was made chief engineer in 1948, and vice-president in charge of engineering in January 1956. He has had more than 100 technical articles published in the fields of electrical engineering and product design.

Mr. Lebens is a registered professional engineer, a member of the American Society of Metals, Missouri Society of Professional Engineers, the St. Louis Electrical Board of Trade, and the Low Voltage Fuse Section of the National Electrical Manufacturers Association.

Shortly after joining AIEE, Mr. Lebens became active in the St. Louis Section. In 1946–47 he was chairman of the Publicity Committee, the following year chairman of the Student Activity Committee, then chairman of the Technical Discussion Groups, and finally secretary-treasurer in 1949–50. He won the Section Prize for the best paper presented before the St. Louis Section in 1951–52.

In 1953, Mr. Lebens was appointed to the AIEE Subcommittee on Switches, Fuses, and Insulators and was made chairman of the Exploratory Working Group on Fuses, 600 volts and below. When the work of this group was completed, he was made chairman of the Working Group to prepare a standard for fuses, 600 volts and below.

Electrical Engineering Education



Construction Begun on MSU Electronic Computer

One of the nation's most advanced electronic computers, capable of solving complex mathematical problems in a matter of seconds, will be put into operation at Michigan State University (MSU) next year.

Construction of the huge machine began this fall in the university's electrical engineering building, announced Dr. J. D. Ryder, dean of the College of Engineering. Its completion is scheduled for the fall of 1957.

Called an electronic digital computer, the device will be similar in logic and general construction principles to the machine developed at Princeton University's Institute for Advanced Study.

Similar machines now are in operation at the Argonne National Laboratory, Oak Ridge National Laboratory, Los Alamos Scientific Laboratory, the Rand Corporation of Santa Monica, Calif., and the University of Illionois. Others are under construction at Iowa State College and the University of Sydney, Australia.

In charge of constructing the MSU computer is Dr. L. W. Von Tersch, who joined the engineering faculty this year after serving as professor of electrical engineering and associate engineer for the Institute of Atomic Research at Iowa State College. He spent the past summer studying the design of "Illiac," the University of Illinois machine.

Dr. Von Tersch explained that once a problem is translated to the machine in terms it can work with, a multitude of problems can be solved by the computer.

An extreme example of the machine's versatility was demonstrated recently at the University of Illinois. Coded musical symbols were fed into Illiac and it responded with the "Illiac Suite for String Quartet," performed by a music faculty ensemble.

To solve 40 simultaneous equations, which would take weeks to do by other means, the computer would need only 193 seconds: 4 seconds for the problem to be introduced, 181 seconds to solve it, and 8 seconds for the answer to be produced.

Its wide usage in solving mathematical problems in many fields of science and engineering will be limited only by the ingenuity of the people working with it.

Because knowledge of coding operations is necessary to make use of the machine, the first course in computer coding at MSU was introduced this term with 60 faculty members and advanced students enrolled. Instructor is Dr. G. P. Weeg, assistant professor of mathematics and former mathematician in design guidance at the Sperry Rand Corporation which developed "Univac" and "Univac Scientific."

Dr. Weeg explained that a computer must be told in minute detail what to do. Its language, however, is different from human language which must be reduced to computer language or coding.

Composed of thousands of miles of wire and hundreds of electronic tubes and transistors, the computer will have four essential sections: input, arithmetic and control, memory, and output.

Information and problems will be introduced to the machine on perforated paper tape. The machine's answers will be reproduced on perforated tape or on a printed page.

Carrier Corporation Offers "Learn While You Earn" Program

Two new "learn while you earn" programs providing the opportunity and financial assistance for employees to work toward college degrees while holding a full-time job have been announced by Carrier Corporation, Syracuse, N. Y.

One of the programs is aimed at developing new engineering opportunities within Carrier. Set up in co-operation with Syracuse University, it offers a series of evening classes enabling high school graduates with the necessary college admission background to complete their freshman and sophomore years in engineering over a period of four years.

Classes are held two to three evenings a week which will give full academic credit toward a degree. Carrier pays 75 per cent of all student costs.

Highly qualified employees after completing these first two academic years may choose either of two options. They may apply for a leave of absence for two years of full-time study on a scholarship paying full tuition costs and leading to a bachelor's degree, or they may take two more years of night study for a third academic year. Students electing the latter choice will be awarded an appropriate certificate.

Announced simultaneously was a new Tuition Refund Plan under which the company will pay 75 per cent of all student costs for any job-related courses which an employee may complete while working full time. With the availability of the new engineering courses, an employee with some engineering credits may complete his academic requirements for the first two years by electing specific courses. He may then qualify for the final two years of full-time, tuition-paid study ending in an engineering degree. Under the Tuition Refund Plan an employee may also secure education in nonengineering fields relating to his job.

The two programs are supplemented by another for post-graduate level engineering education initiated recently by Carrier. This third plan makes it possible for graduate engineers to obtain advanced degrees in mechanical engineering on a part-time basis without cost.

Thus, an employee could conceivably come to Carrier as a high school graduate and progress to a master's degree in engineering over a period of years while working full time all but two of those years and with most of his student costs paid for by the company.

Under the graduate engineering training program, three and one half years of study are required for a master's degree. First classes now under way at University College include 22 Carrier engineers. Unlike most such programs, extra expenses incurred by the University to set up the graduate courses are likewise covered by Carrier.

The Carrier arrangement with Syracuse University to make such courses available on a part-time basis may also permit others in the community to complete academic requirements leading toward engineering degrees while working full time, it was pointed out.

In addition to these employee programs, the Carrier Foundation each year provides full-term engineering scholarships in four selected universities, open to all qualified high school graduates, with selections being made by the colleges involved.

Members Elected for Sigma Tau National Council

Members of the Sigma Tau National Council were elected at the close of the three-day National Convention held at Boulder, Colo., October 4–6, 1956. The University of Colorado chapter served as hosts this year.

C. B. Mapes, a civil engineer of Tulsa, Okla., was advanced to the office of National President of Sigma Tau; M. J. Cook, vice-president of the Bell Laboratories, New York, N. Y., will serve as vice-president of the National Council; and C. A. Sjogren of Lincoln, Neb., will continue as national secretary and editor of the quarterly publication.

The number serving on the National Council was increased to six with the election of T. D. Carr, dean of the College of Engineering, University of Kansas, being the additional member.

C. W. Leighy, editor and publisher of *Electrical West*, retired from the presidency after eight years in that office. He and R. P. Moser, General Electric representative in the Seattle, Wash., area will remain as members of the National Council.

At the business sessions of the convention, reports were read by the 31 delegates representing the undergraduate chapters of Sigma Tau. Several changes in the constitution were approved and, in keeping with past practices, the Sigma Tau Distinguished Service Awards were presented this year to Dean C. L. Eckel and Prof. C. A.

Wagner of the University of Colorado, and Prof. J. K. Ludwickson of the University of Nebraska, for distinguished service in engineering education, for leadership in engineering progress, for demonstrated ability in inspiring others to great achievement, and in appreciation of continuing services to the Fraternity.

Col. A. A. Dobson and C. W. Roberts, both of Lincoln, Neb., chairman and member of the national finance committee, received the Distinguished Service Award in recognition of their distinguished role as engineers and executives, and in appreciation of their continuing service throughout the years to the Fraternity.

Sigma Tau is a national engineering honor society, founded in 1904. It provides recognition and encouragement of advanced engineering students for superior scholarship and promise of professional attainment. With 31 chapters in engineering colleges in the United States, the society has a total of 23,500 members. The organization is a member of the Association of College Honor Societies.

International Nickel Gives $1 Million in Educational Grants

Educational grants totaling approximately $1 million by The International Nickel Company, Inc., in its program for aid to higher education in the United States, have been announced by J. F. Thompson, chairman of the Board of Directors, and H. S. Wingate, president of the company. Some $400,000 of these grants will be for the current 1956–57 academic year, with approximately 85 universities and colleges sharing in the grants. The remaining $600,000 will be applied to extending its fellowships and scholarships during the following four years.

These gifts by the company reflect a continued realization that it is essential for the progress of its own and other industries to strengthen and expand higher education programs of universities and liberal arts colleges and to stimulate and promote adequately trained and well-rounded technical personnel.

The major portion of the grants will be devoted to fellowships and scholarships, and a limited amount will be applied to special projects and gifts. The company's present fellowship program will be expanded to establish one research fellowship in each of 10 major universities, and provision is made for the establishment of 10 teaching fellowships, 57 scholarships, and three special summer courses for teachers of science and mathematics and guidance counselors in preparatory schools and high schools.

The research fellowships will be established for a period of five years. They will foster fundamental research in science and will provide an annual stipend of about $4,200 to the fellow and include an annual grant of an equal amount to the institution in which they are placed.

The teaching fellowships will be established for a period of three years. They will provide an annual stipend of $3,000 to the recipient and an annual grant of $1,000 to the institution in which they are placed for training of teachers of science and mathematics in preparatory schools and in colleges.

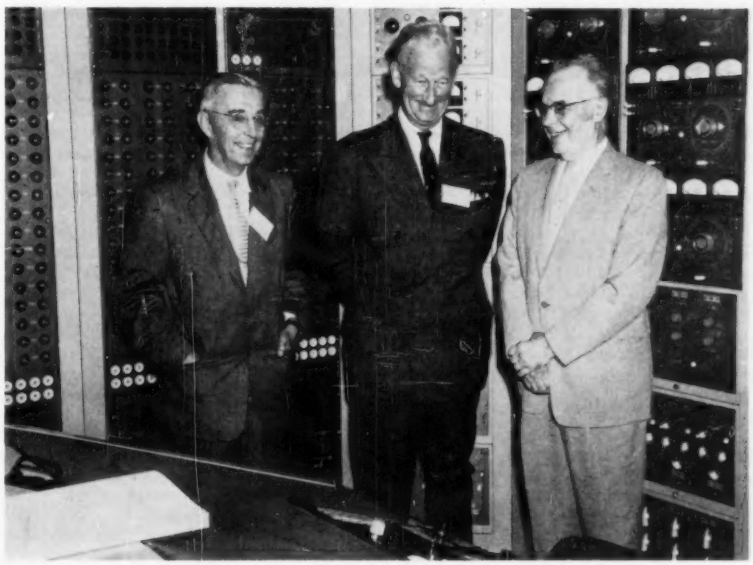
Summer refresher courses for teachers of science and mathematics and guidance counselors in preparatory schools are provided for with an annual grant of $5,000 to each of three institutions.

The annual value of the 57 scholarships will range from $750 to $1,000 each for tuition and a proportion of living expenses for the recipients and a grant of $500 to the school as a cost-of-education supplement. These scholarships will be awarded by the colleges concerned.

Forty-seven of the scholarships will cover instruction in engineering, with preference to the fields of mining, geology, and metallurgy, in order to encourage students to choose these fields for careers. Especially important and novel are 15 of these scholarships which will be placed in 10 engineering institutions which have combined study "3–2" programs with 105 liberal arts colleges; in these cases a cost-of-education supplement will be allowed to the liberal arts colleges as well as to the engineering institutions to which the college student transfers. There are also 32 scholarships for similar study in selected private and tax-supported institutions; eight of these will be awarded through the National Merit Scholarship Corporation. In addition, there will be 10 scholarships for children of the company's employees which will permit free choice of school and field of study.

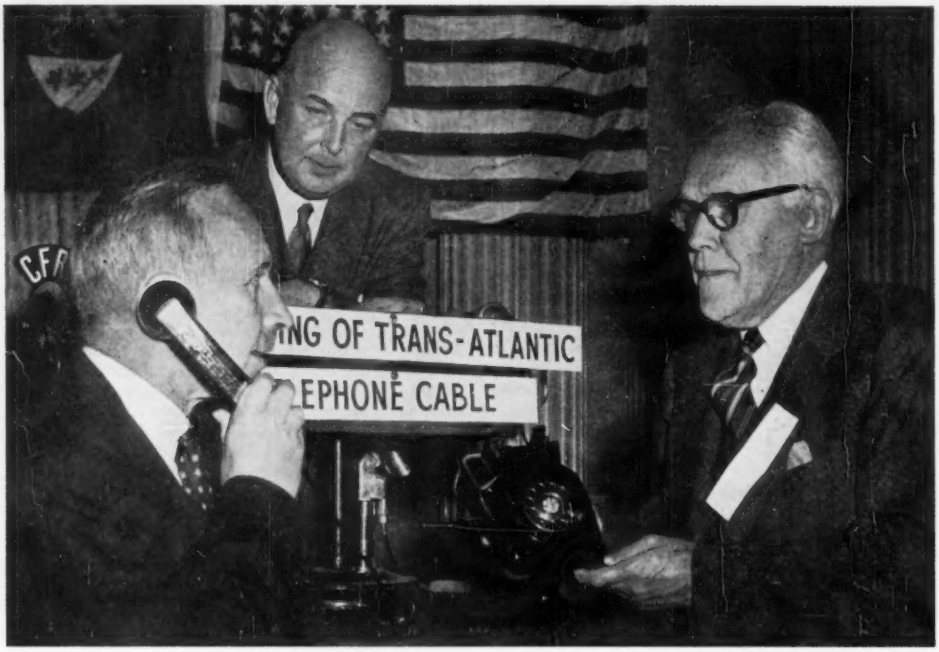
A similar program for aid to higher education in Canada was announced recently in Toronto, Ont., by The International Nickel Company of Canada, Ltd., the parent corporation.

University of Missouri Network Analyzer



AT DEDICATION CEREMONIES held in the Engineering Laboratories, the University of Missouri accepted a gift of a $200,000 Power Network Analyzer donated to the College of Engineering by a group of Missouri industrial firms. Dean H. O. Croft (*left*) of the College of Engineering introduced the two dedication speakers; Gen. L. J. Sverdrup (*center*), president of Sverdrup and Parcel, Inc., made the presentation for the donor companies; and President Elmer Ellis (*right*) accepted the gift for the University of Missouri. With the acceptance and dedication of the complex instrument, the University has inaugurated power system analyzing service for industry of Missouri and the Midwest, as well as a new research and teaching program for further advancement of engineering science.

OF CURRENT INTEREST



GOLD-PLATED phone is used in three-way conversation with C. F. Craig, president of American Telephone & Telegraph Co.; Dr. Charles Hill, United Kingdom Postmaster General; and G. C. Marler (holding phone to ear) Canadian Transport Minister. D. F. Bowie (center) and T. W. Eadie (right) listening in.

Capital Press Service Photo

Transatlantic Laying of Telephone Cable System Completed

A NEW CABLE SYSTEM for transatlantic telephone calls—the first physical voice link to be established between North America and Europe—was inaugurated and opened to public service recently.

In the first call, C. F. Craig, chairman of the board of American Telephone and Telegraph Company (AT&T) exchanged greetings with Dr. Charles Hill, head of the British Post Office (BPO), who spoke from London, England. Their conversation, carried with the clarity and naturalness of a neighborhood call, highlighted inaugural ceremonies held in the United States, Canada, and Great Britain.

Mr. Craig also exchanged greetings with George Marler, Canadian minister of transport, in Ottawa, Ont., Canada.

The cable system, under construction for more than two years, not only is the first of its kind to cross the Atlantic, but also is the first underwater telephone link to span any ocean. AT&T, the BPO, and Canadian Overseas Telecommunication Corporation (COTC) are partners in the historic enterprise.

Different from Telegraph Cables

Telegraph cables have been operating under the North Atlantic Ocean ever since 1858. Today there are 20 of them beneath that part of the sea—and many more in other sections of the world. The new transatlantic telephone cable has plenty of company—but its characteristics are much different from the rest.

The main difference is in its capacity to carry information. The transmission of dots and dashes, or teletypewriter signals, requires a bandwidth of about 100 cps. By contrast, the telephone cable has a bandwidth of 144,000 cps. In other words, it can transmit 1,400 times as much information.

The deep-sea portion of the system was laid under the supervision of the long lines department of AT&T, the long distance operating unit of the Bell System. Engineers and scientists of Bell Telephone Laboratories designed and tested the system.

The transatlantic system can carry 36 conversations at the same time. Thus, it is able to handle about three times the traffic now transmitted between this continent and Great Britain by radiotelephone.

The deep-sea segment of the system extends 2,250 miles from Clarenville, a small village on the east coast of Newfoundland, to Oban, Scotland. From Oban, new trunk lines link the system to switchboards in London, England.

On the North American continent, newly constructed land and water sections bring the transatlantic circuits to Portland, Me., and to Montreal, Que., Canada, where they connect to the established networks.

The underwater cables that represent the backbone of the system were placed by the cableship *H.M.S. Monarch*, the largest cable-laying vessel afloat.

The 8,050 ton *Monarch* took a total of seven months to complete laying operations. She worked only in Summer, when the turbulent North Atlantic is on its best behavior. At that, she took a battering from hurricane Ione in September 1955, but finished her job on schedule.

Because cables of the design used in the Atlantic section of the system transmit in but one direction, two cables were needed to make a conversation possible. The two cables lie some 20 miles apart on the ocean floor; the southernmost transmitting west to east and the northernmost east to west.

Both cables, which have an average overall diameter of $1^1/_4$ inches, were put down in three segments. In June 1955, 200 miles of the west to east cable was placed from Clarenville to the edge of the Continental Shelf. A second segment extended this cable to a point 500 miles off Scotland and the third closed the gap. This past summer, the process was reversed.

Some 300 miles of cable was also placed

across Cabot Strait in the spring of this year, linking the terminal at Clarenville to the new land line at Sydney Mines, Nova Scotia.

The particular problem that had to be overcome was development of an underwater amplifier, or "repeater," an electrical device that would boost voice signals after they had reached the fading point along a circuit. While repeaters are relatively easy to install and maintain along land cable, the undersea cable demanded an amplifier that could: (1) be built into the cable in such a way as to be able to pass easily through a ship's laying gear without interruption; (2) withstand pressures of at least 6,000 pounds per square inch; and (3) operate without attention for at least 20 years.

Bell Telephone Laboratories, after years of research, perfected such a repeater, which has been under test for 15 years and in operation in cables stretching from Florida to Cuba since 1951.

The repeaters, about eight feet long, appear as a slight fattening in the cable and might not be noticed by the unpracticed eye as they slide seaward from the ship's gear. To keep signals constant and clear, 51 repeaters, spaced about 40 miles apart, are located in each cable.

Undersea Cable Takes to the Air

The new undersea telephone cable is like a porpoise in one respect—it leaps from water to air. Length of the leap is 575 miles, from Portland, Me., to Sydney Mines, Nova Scotia. At Portland, the transoceanic system is linked to established domestic circuits, which carry voices to the New York, N. Y., area, and then to any part of the nation. From Sydney Mines, the transoceanic circuits are carried by shallow water submarine cable to Clarenville, Newfoundland, and from there to Scotland by deep-sea cable.

The Portland-Sydney Mines hop is by radio relay towers, spaced an average of 30 miles apart. Securing rights-of-way for the tower installations and then constructing the facilities, was a task of several years. It was done simultaneously with the work on the deep-sea portion of the transoceanic system.

Radio relay, which first spanned the continent five years ago, is an electronic "pony-express" method of communications widely used by the Bell System. Signals are beamed by high frequency radio waves from tower to tower over line-of-sight routes throughout the United States.

Route Selected Rechecked

The route of the twin telephone cables on the floor of the Atlantic Ocean was carefully plotted in advance—then rechecked many times. Often the depth of the sea was measured by the cableship *Monarch* as the cable itself was being laid. This was done with a device called a fathometer, which bounced sound waves off the sea bottom. Precise timing of the bounce determined the depth of the ocean.

Care was taken to avoid laying the cable in ocean holes, where the bottom drops off suddenly, as the cable might have kinked. Also, the route from Clarenville to Oban was selected to avoid telegraph cables in the North Atlantic. All of them lie to the south.

The slightly different ocean bed produced a variation in the lengths of the two cables. The Oban–Clarenville cable is 2,250 miles long, and the Clarenville–Oban cable is somewhat shorter.

Part of the transatlantic telephone cable is not in the ocean at all but, instead, is buried across a 64-mile neck of "land" in Newfoundland. "Land" is hardly the proper term, however, for the route of the cable section which runs from Clarenville to Terrenceville. Much of it consists of "muskeg," which is a type of bog containing moss lying over water. It appears to be solid, but often men sink to their hips when trying to stand on it.

Cable-laying through muskeg, as well as innumerable lakes, ponds, rivers, inlets and bays of Newfoundland, was no easy task. Special trench-making equipment was used, and cable reels were inched along with the help of wooden poles. The cable itself was of submarine instead of land design—the same as the underwater section from Newfoundland to Nova Scotia.

Terminals in Scenic Towns

True "travelogue" towns are the settings for terminal stations of the transatlantic telephone cable—Clarenville, Newfoundland, and Oban, Scotland.

Clarenville nestles on the shore of Random Sound, on the eastern coast of Newfoundland. Pine-covered hills are its background and small icebergs are a common sight off shore. Although there is cod fishing out of Clarenville, most of the town's 12 hundred inhabitants are occupied with railroading. It is an important link in the Canadian National Railroad.

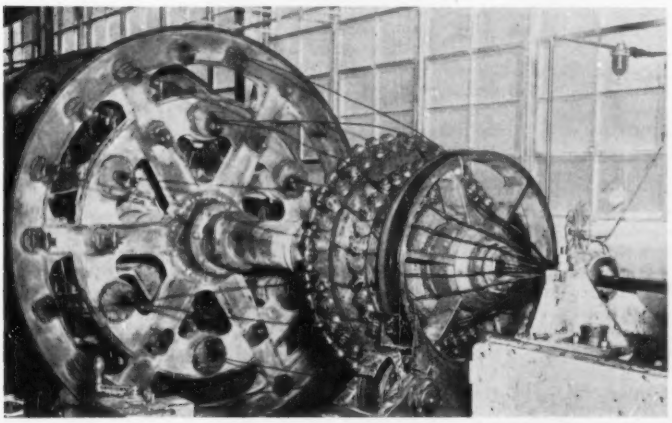
On the other side of the Atlantic, Oban fronts on Kerrera Sound with rocky hills to the east. Oban is famed as a summer resort, both for the rugged beauty of its coastline and its two medieval castles nearby. Its population of 6,000 is greatly increased by tourists in season. Out of season, herring fishing is its important industry.

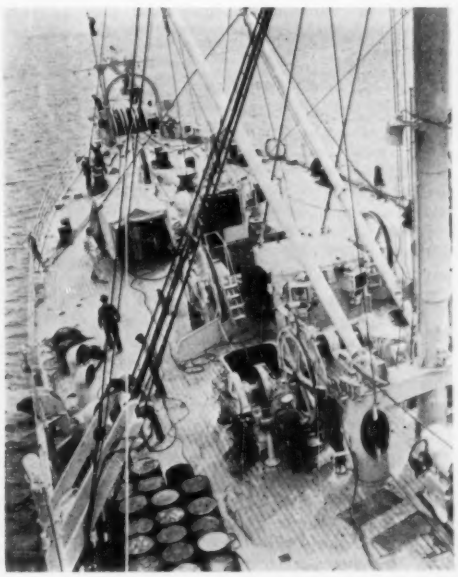
Both Clarenville and Oban have been considered off civilization's "beaten paths"—but the transatlantic cable now makes them only seconds away from the world's major cities.

Without the efforts of thousands of the United States Bell System employees and British and Canadian telephone people there would be no transatlantic telephone cable. Singling out individuals can be symbolic only, but eight men typify Bell System contributions. Five are Midwesterners, two Southerners, and one is from New England.

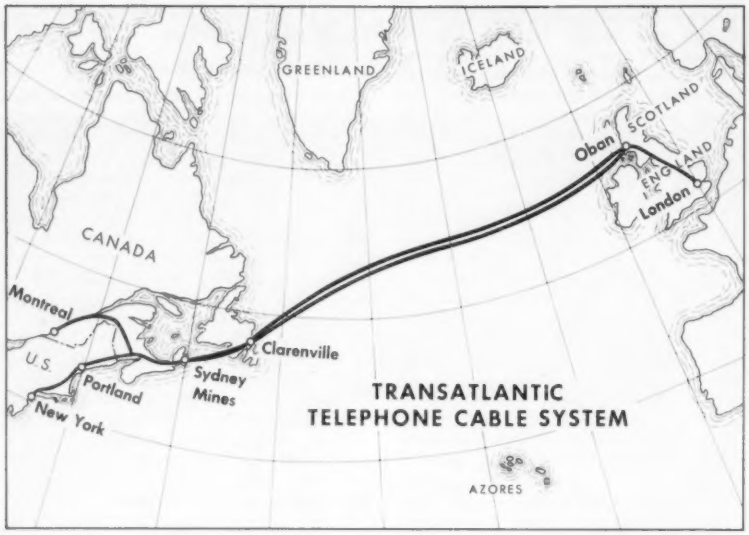
Two of the eight are Bell Laboratories men—Dr. O. E. Buckley, a native of Sloan, Iowa, and Dr. M. J. Kelly, of Princeton, Mo. Dr. Buckley headed the small group that first began submarine telephone cable studies as far back as 1919. Succeeding him at the helm of that Bell System unit was Dr. Kelly, who has led the project's design phase to its successful conclusion, in addition to directing all other endeavors of the Laboratories.

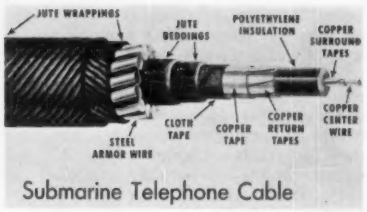
Six members of AT&T have been close to the cable for many years. G. L. Best,





FOREDECK of cableship *H.M.S. Monarch* that laid new transatlantic telephone cables *(right)*. Gear on both sides of deck is mechanized to haul cable from storage tanks below. When laying in shallow water, cable is fed over sheaves which can be seen on prow of ship. In deep water, vessel pays cable over sheaves in stern. Tent near rail on port side provides protection for splicing operations. A portion of the submarine cable used in new transatlantic telephone system during manufacture (above) at plant located in Newington, N. H.





CUT-AWAY VIEW *(above)* **of a part of the transatlantic telephone cable shows its intricate make-up. Diameter of the full section is 1.84 inches. The route of the transatlantic telephone cable system is shown on the map** *(left)*. **It stretches 3,205 miles from Portland, Me., to Oban, Scotland.**

vice-president in administration took a leading part in the intricate negotiations with British and Canadian telephone personnel that led to the vast, co-operative project.

The five other AT&T men are of the long lines department. H. T. Killingsworth, vice-president in charge of the department has not only guided all other phases of long distance communications, but also has had the responsibility for construction of the transatlantic cable and now of its operation.

W. G. Thompson, assistant vice-president in the long lines department has co-ordinated many complex parts of the cable project, especially at the Government level.

Directing the construction phases of the cable system, and now its maintenance and operation is R. L. Helmreich, the department's director of operations.

Also active in the construction project was C. C. Duncan, general manager of the group overseeing the cable installation, and now its assistant director of operations. Assisting on the cable project was J. S. Jack, who directed the cable laying itself, and was aboard the cableship during the transatlantic operations.

Statistics and Facts

About 4,500 nautical miles (5,175 statute miles) of cable was manufactured; including slack, spare, and cable for trial laying. Manufacture of the cable required: 25 million pounds of steel wire, 6.6 million pounds of copper, 2.5 million pounds of pitch compounds, 5.5 million pounds of jute, 3.3 million pounds of polyethylene compound, and 3.2 million yards of cloth tape.

1876 Alexander Graham Bell invents telephone; hopes to attach speaking equipment to then existing Atlantic telegraph cables—not a whisper is heard—Bell drops idea but not dream of talking to Europe.

1919 Technicians of Bell System begin studying problems of long distance undersea telephone cables.

1925 Planning well under way for a single-circuit, repeaterless voice cable across North Atlantic.

1927 Cable need minimized when radio-telephone service to England opens.

1932 Depression reduces demand for additional overseas circuits. Simultaneously, research shows amplifiers for submarine cables—making possible development of a multichannel cable—are definitely feasible.

1941 Testing begins on long-life repeater tubes.

1952 Underwater repeatered cable from Florida to Cuba so successful that AT&T re-examines Atlantic project—arrangements are discussed with BPO and COTC.

1953 Three parties sign final agreement—manufacturing begins.

1955 March—*Monarch* makes test lay of cable west of Gibraltar.
June 22—Laying cable No. 1 from Clarenville east to Oban begins.
September 26—Laying completed for cable No. 1 at Oban.

1956 June 4—Cable ship begins laying cable No. 2 from Oban to Clarenville.
August 14—Laying completed for cable No. 2 at Clarenville—final splice made.
September 24—Circuit layouts and final testing completed—transatlantic telephone cable system ready for service.

Giant Tracker Watches Missiles That Are 300 Miles Away

A GIANT telescopic tracker capable of tracing a missile 300 miles away, which clearly shows fast moving aerial objects in natural color on the instrument's scope, has been developed at the Army Signal Corps Engineering Laboratories at Fort Monmouth, N. J.

The new $1^1/_2$-ton optical collossus, which has a 400-pound lens of 160-inch focal length, developed by Fairchild Camera and Instrument Corporation, simultaneously takes black and white photographs of rockets, jets, and other flying objects automatically. The new equipment, currently undergoing tests at White Sands, N. M., has already made an impressive record.

Engineers have given the tracker a four-point record of achievement: good telephotographic lens and camera system, precise co-ordination of target and time records, reliable target acquisition, and fast and accurate tracking.

Reflective Type Optics Used

Heart of the main optical system in a 40-inch focal length Cessegrain type of reflective optics. Important advantages of this type are high transmission of light, no chromatic aberration, reduced over-all size which in itself is an important factor in tracking, and the use of large apertures with a relatively small opening. The optics, which were designed by the noted lens expert Dr. J. G. Baker, include a turret of projection lens of 4X, 2X, 1X, and 1/2X magnification providing effective focal lengths of 160, 80, 40, and 20 inches respectively. The entire field of view of this optical system varies from $1^1/_4$ to 5 degrees depending on the projection lens in use.

Precision Timing

The camera, designed and built by Fairchild, has a capacity for taking up to 20 pictures per second, although most of the work has been done at 4 pulses per second (pps). To provide an accurate film record of target information, almost perfect frame-to-frame film registration has been achieved, even at the 20 pps speed.

Angular data obtained from the precision scales is also recorded photographically. The main camera photographs the target and records the reading of a clock on the same frame. An auxiliary camera photographs a data display unit which indicates the orientation of the pedestal in elevation and in azimuth. It also mounts a second clock which is synchronized with the first. Additional fine and coarse servomechanism driven position indicators may be connected through data transmission cables.

The main camera uses 70-mm film, the data camera 35-mm film. Both are pulse

synchronized at approximately four frames per second. Both cameras are put in operation a few second before test time, so they are running at constant speed at zero time. The 70-mm film shows photographs of the main camera's field of view only, while the 35-mm film remains blank.

Activating Cameras

The first firing range pulse, marking on target time, will activate a holding relay which supplies power through a micro switch synchronized with shutter opening, thus operating flashing lamps illuminating the data dials and both clocks, and also a neon lamp arranged to produce a reference mark on the 70-mm film. Another reference mark on this film is produced by a neon lamp arranged to operate directly from and in synchronism with the first range pulse received.

Both of these marks are applied to the film ahead of the loop where the film motion is steady and continuous. The spacing between the two marks thus is an exact measure of the elapsed time between the missile lift and the initial clock photograph.

This high degree of accuracy means that the film not only will reveal information as to type of object, but also will determine its velocity, rate of acceleration, elevation, and azimuth. These, along with radar range information, will give a precise location of the missile at any point in time, in order to take proper action.

Crystal Ball Gazing

Fast and accurate tracking is obtained manually by "crystal ball" control of a servo system. This device, used for several years in anti-aircraft controls eliminates the free slewing method and the method of hand turned elevation and azimuth wheels. This latter method often required a two-man team. In actuality, the operator or tracker, moves the "crystal ball" so that the image of the target, seen through the tracking telescope, remains centered on crosshairs. Manual positioning is accomplished by the operator using the "crystal ball." The "crystal ball" is a steel sphere which is rotated in a socket by the operator. It moves the instrument in both the horizontal and vertical planes. A seat for the operator is mounted on the pedestal and rides with it. The pedestal comprises a base section which is rigidly attached to the platform, and a head section movably mounted on the base and capable of rotation on vertical and horizontal axes.

In addition to manual input orientation by the "crystal ball" method, a syncro system can also be employed to orient the tracker on the basis of data received through a data transmission system or from radar. For example, an object beyond the telescope's range, could be picked up on radar which in turn would position the tracking telescope on the object even before the object was visible to the operator.

Inasmuch as the instrument can be remotely controlled, it may be located in danger areas to record the impact of rockets and other missiles.

Self-contained in the platform of the tracker are the motor drives and controls necessary to move the scope into position. On top of this is a large pedestal consisting of a base section fixed to the platform and a head section or trunnion mounting. The trunnion mounting also built by Fairchild holds the entire optical system and provides it with movability through two axes.

The tracker unit is being tested on a variety of vehicles and artillery type carriers.

OPTICAL TRACKER follows a target as directed by a radar set, and, conversely, a radar may follow a target as directed from data recorded by the telescopic instrument.

U. S. Army Photograph

Future Meetings of Other Societies

American Mining Congress, Annual Meeting, December 3, New York, N. Y.

5th Annual Symposium, Technical Progress in Communication Wires and Cables, December 4–6, Berkeley-Carteret Hotel, Asbury Park, N. J.

SPI, Film, Sheeting, and Coated Fabrics Conference, December 4–5, Hotel Commodore, New York, N. Y.

Instrumentation Conference and Exhibit, PGIRE, December 5–7, Biltmore Hotel, Atlanta, Ga.

AIME, 14th Annual Electric Furnace Steel Conference (Celebrating 50th Anniversary of Electric Arc Process), December 5–7, Morrison Hotel, Chicago, Ill.

Wright Brothers Lecture, December 17, U.S. Department of Commerce Building Auditorium, Washington, D. C.

RETMA, Symposium on Applied Reliability, December 19–20, Bovard Hall, University of Southern California, Los Angeles, Calif.

American Association for the Advancement of Science, Annual Meeting, December 26–31, Statler Hotel, New York, Y. Y.

American Physical Society, December 27–29, Monterey, Calif.

Mathematical Association of America, Annual Meeting, December 29, University of Rochester, Rochester, N. Y.

ACS, Division of Industrial and Engineering Chemistry, Christmas Symposium, Princeton University, Princeton, N. J.

1957

IRE-ASQC-RETMA, 3rd National Symposium on Reliability and Quality Control, January 14–15, Hotel Statler, Washington, D. C.

13th Annual National Technical Conference, January 16–18, Hotel Sheraton-Jefferson, St. Louis, Mo.

National Motor Boat Show, January 19–27, New York Coliseum, New York, N. Y.

National Bureau of Standards, joint IRE Symposium on Very Low Frequency Electro-magnetic Waves, January 23–25, Boulder NBS Laboratories, Boulder, Col.

IRE, Symposium on Microwave Ferrite Devices and Applications, January 28–29, Engineering Societies Building Auditorium, New York, N. Y.

Many Body Problem, Nuclear Compounds, January 28–29, Stevens Institute of Technology, Hoboken, N. J.

Institute of Aeronautical Sciences, joint IRE meeting, Electronics in Aviation Day, January 30, Sheraton-Astor Hotel, New York, N. Y.

3rd Annual Midwest Welding Conference, joint Armour Research Foundation of IIT and American Welding Society, January 30–31, Illinois Institute of Technology Chemistry Building, Chicago, Ill.

S.A.M.E., 3rd Military-Industrial Conference, February, Chicago, Ill.

American Society of Heating and Air-Conditioning Engineers, 66th Annual Meeting and 2nd Exposition, February 1–5, Dallas, Tex.

26th Annual Midwinter Conference, Public Utility Buyers' Group, February 3–5, The Brown Hotel, Louisville, Ky.

ASTE, Committee Week, February 4–8, Benjamin Franklin Hotel, Philadelphia, Pa.

National Auto Accessories Exposition, February 4–8, New York Coliseum, New York, N. Y.

Western Winter Radio-Television and Appliance Market, Division of Western Home Goods Market, February 4–8, Western Merchandise Mart, San Francisco, Calif.

Symposium on Recording Heart Sounds, February 14, University of Buffalo Medical School, Buffalo, N. Y.

National Photographic Show, February 16–24, New York Coliseum, New York, N. Y.

National Electric Sign Association, Annual Convention and Exhibit, February 17–20, Sheraton Park Hotel, Washington, D. C.

ASCE, Semiannual Convention, February 18–22, Jackson, Miss.

ASHAE, 63rd Annual Meeting, February 25–28, Chicago, Ill.

13th International Heating and Air-Conditioning Exposition, February 25–March 1, Chicago, Ill.

Man Conquers Heat
One Eighth as Hot as Sun

A suit that enables a man to work in temperatures one eighth as hot as the sun's surface was demonstrated in New York recently.

The demonstrator entered an industrial furnace heated to 1,200 F, six times the highest temperature ever entered publicly for more than a few seconds. He stayed two or three minutes each time as if on a repair or rescue mission.

The demonstration, which was sponsored by Minnesota Mining and Manufacturing Company (3M), St. Paul, Minn., was held to show the heat-protective qualities of fabrics coated with a thin layer of aluminum—a process developed by 3M. The aluminum-coated fabric reflects radiant heat instead of insulating against it.

To demonstrate the intense heat from which he was protected, an engineer wearing the aluminum-coated suit walked into the 1,200 F oven carrying an armload of wood which burst into flames while he held them.

He returned with a sheet of steel wool which flared almost immediately, and then a manikin wearing a fireman's rubber fire-fighting coat and another wearing ordinary street clothes, both of which burned while he was unaffected.

He took in a wicker armchair and sat in it while it burned, and he topped off the demonstration by carrying in a half-inch-thick steak that cooked to medium-rare in about $1^1/_2$ minutes—while he didn't.

The demonstrator was D. J. Bennett, an engineer from Zanesville, Ohio, who reported he had tested the suit previously "about 200 times" in industrial repair work in ceramic kilns at temperatures that were in the 1,200 F range.

It was the first public showing of the 3M brand aluminized fabric used in the suit. The fabric has been undergoing on-the-job evaluation in hundreds of such suits in industrial plants during the past four years, the 3M company said.

The furnace selected for the demonstration was a ceramic box furnace at Seaporcel Metals, Inc., Long Island City, N. Y., where temperatures could be maintained at a level of 1,200 F.

The suit has been worn in temperatures up to 1,400 F, and the demonstrator stated that he had never felt the heat.

"Nine-tenths of the heat is reflected away by the aluminum coating," it was stated, "and the little heat that gets through is dissipated by the layer of glass fiber quilting beneath the aluminum coating. The only heat felt is the accumulation of body heat."

The suit used in the demonstration—produced by Fyrepel Products, Inc., of Newark, Ohio—has the aluminum coating on a fiber glass material which is backed up with fiber glass quilting. It is designed for intense heat.

Other existing garments are produced from 3M's aluminum-coated light asbestos (1.2-pound herringbone, Underwriter's grade) or aluminum-coated cotton duck. These require no other insulation. Their light weight, flexibility and durability permit them to be worn all day by workers in hot areas, such as near steel furnaces.

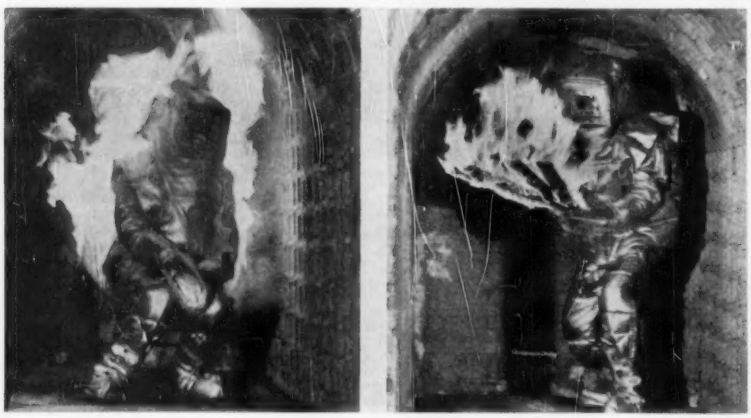
Both the cotton duck and light asbestos are equally heat-protective, but the asbestos also protects against molten splash while the cotton duck does not, 3M representatives said.

One safety garment maker uses aluminum-coated glass fiber material, backed by a layer of rubber, to produce a fireman's fire-fighting coat. The result is a lighter coat, easier to work in, yet with greater heat protection. The layer of rubber makes the coat waterproof.

A smock worn by steel workers is so light and flexible that the wearer hardly knows he has it on; so he wears it.

The 3M company announced it is now coating aluminum on asbestos and cotton duck as stock items, and is coating such other materials as fiber glass on special order. Twelve manufacturers of industrial clothing are now offering such aluminized clothing nationally.

During four years of field evaluations, the aluminized fabric has saved lives, prevented property damage, and saved hundreds of thousands of dollars in production time by permitting quicker entry into hot areas.



ALUMINIZED GARMENTS now being manufactured include fire-fighting coats for firemen; long-coats, aprons, spats, and gloves for steel workers; coats, suits, gloves, and helmets for stand-by fire-fighting equipment in industrial plants; quilted suits (*shown above*) with aluminum-coated fabric for use in industrial ovens and furnaces; suits for emergency personnel at airports, oil fields, and other locations where emergency action can save time, money, and lives; and other garments designed for specific "hot jobs."

W. F. Ryan
ASME 1956–57 President

W. F. Ryan, vice president, director, and senior consulting engineer of Stone and Webster Engineering Corporation, Boston, Mass. has been nominated to serve as the 1956–57 president of The American Society of Mechanical Engineers (ASME) and installation will be at the society's annual New York, N. Y., meeting.

The new president holds an A.B. degree awarded in 1911 and an MME degree conferred in 1913 from Harvard College. The Catholic University of America conferred on him the degree of Sc. D. in 1954.

Dr. Ryan joined Stone and Webster Engineering Corporation in 1929. He became a member of the ASME in 1917 and has served in numerous committee, divisional, and delegate assignments for the society. He currently is ASME representative on the Engineers Joint Council, Engineering Council for Professional Development Committee on Practice of Engineering, and as advisory member of the Power Division Executive Committee.

He is also active in the National Society of Professional Engineers, American Society for Engineering Education, United States Naval Institute, American Ordnance Association, Engineers Council for Professional Development, International Electro-Technical Commission, and Harvard Engineering Society.

Fish Use "Radar"
To Elude Fisherman's Hooks

Do fish talk to each other?

A Yale University scientist recently stated that "it would almost seem as if they must." Moreover, he indicated that they use "radar" to elude fishermen.

Daniel Merriman, director of the Bingham Oceanographic Laboratory and associate professor of Biology at Yale, explained that fish do make noises. Therefore, underwater acoustic devices are being used to help locate new supplies of fish.

As a result of such devices and of research carried on in the Bingham Laboratory and in other similar institutions, oceanographers recently found a great concentration of animal life between 400 and 600 feet deep over all the oceans of the world.

At present, it is not economically feasible to harvest and market this particular crop. However, modern sonic detection instruments are now widely used in locating certain commercially important fish—schools of herring, for example.

There is much evidence to show that fish use sound waves as radar—to detect the presence or absence of obstacles in their path. For example, they can pick up and escape through a hole in a confining net in murky water where they cannot possibly see the aperture.

The new techniques provided by oceanographers for locating fish are helping to increase the world food supply, according to the Yale scientist. But the untapped resources of the oceans include much more than food and minerals. The ocean is considered to be an immense reservoir of tremendous untapped sources of power, water, chemicals of

all kinds, salt, calcium, magnesium, petroleum—all found in the sea.

The energy of ocean waves can be exploited for power purposes in certain areas, particularly along exposed coasts on the western side of the continent. Harnessing this potential power source is going to be a huge engineering feat, but should not faze anyone of this age.

Work, thus far, has been mainly concerned with pointing out things that exist in the ocean; how much can be done to get them within the limits of current economy is something else again. Information is being provided for the rational utilization of materials from the sea.

Mauna Loa Observatory To Study Atmospheric Phenomena

A unique high-altitude observatory on the slope of the Hawaiian volcano, Mauna Loa, was dedicated recently for joint use by the National Bureau of Standards (NBS) and the Weather Bureau. Located at a height of 11,134 feet in the tropics, where the upper atmosphere is very clear and usually of low moisture content, the new observatory offers special advantages for many types of astronomical and upper-air studies. It will make possible continuous observation of atmospheric phenomena with manned instruments in place of the unmanned meteorological balloons that have been used for the most part in high-altitude work.

The new observatory is expected to provide valuable data in a variety of fields. Its advantages as a high-altitude observatory are due to the fact that it is situated well above the bulk of the dust and moisture contained in the earth's atmosphere. At the latitude of Hawaii a "trade wind inversion layer" usually traps the dust and moisture below about 8,000 feet.

Other important advantages of the Mauna Loa Observatory are its ready accessibility and relatively warm climate. Most of the other comparable observatory sites are buried in snow during winter and part of the summer. Also, the Mauna Loa Observatory has the required altitude without the ruggedness that imparts turbulence to the surrounding air, and it is situated at a key point for studying the huge air masses of the tropics.

The chief research results to be expected from the observatory are improved long-range weather forecasting and greater knowledge of solar and atmospheric radiation. Because the air masses of the Pacific are responsible for much of the weather that occurs in other parts of the world, data on these air masses may make it possible to forecast conditions in distant places.

There is some evidence that the ozone content of the lower atmosphere in the tropics is associated with the formation of the large low-pressure areas that produce typhoons. Continuous measurement of atmospheric ozone may thus be of assistance in forecasting typhoons in advance.

The observatory also offers possibilities for study of cosmic rays, total solar radiation, snow crystals, air glows, and possibly radioactive fallout. In July, C. C. Kiess and C. H. Corliss of NBS began a study of the moisture content of the planet Mars under the auspices of the National Geographic Society. They used spectroscopic techniques to investigate the light reflected to Earth from Mars. The advantageous location of the Mauna Loa Observatory made it possible to reduce the effect of the earth's atmosphere on the planet's spectrum.

Device Records 300-Page Book in 30 Seconds

Development of a new electronic device which can record in 30 seconds data equal to the number of words in a 300-page book was announced recently. The instrument, known as "Computer Readout, Model *100*," is designed to record information turned out by the massive "electronic brains" of major computer laboratories. It was developed by the Stromberg-Carlson Division of General Dynamics Corporation.

At the heart of the system is the Charactron shaped-beam tube, developed by Stromberg-Carlson's San Diego Division, as is the computer readout. This tube acts as a sort of electronic typewriter, recording in permanent, readable form the output of computers at speeds 10 times greater than any other method ever attempted. The first of the devices will be installed at the Operations Research Office of Johns Hopkins University in Baltimore, Md.

Modern computers turn out information so fast that ordinary recording devices just cannot keep up, and valuable programming time frequently is wasted as answers are transcribed.

The Charactron tube utilizes a stream of electrons, extruded through tiny metal stencils, to create numbers and letters at split-second speed on a phosphor-coated screen, similar to the screen of a television set.

This tube, designed type *C7C11*, reproduces letters and numbers 0.0030 of an inch high. Utilizing this tube, the Model *100* can reproduce and photograph these tiny characters at the rate of 10,000 per second. The screen or face of the tube can accommodate a maximum of 6,500 letters and numbers at any one time. Thus, the screen can be filled three times in two seconds and at that rate a 300-page book of 50,000 words (300,000 characters at an average of 6 characters per word) could be reproduced in just 30 seconds.

The face of the tube is positioned in the assembly so that the letters and numbers reproduced can be recorded by a specially designed camera on 35-mm film.

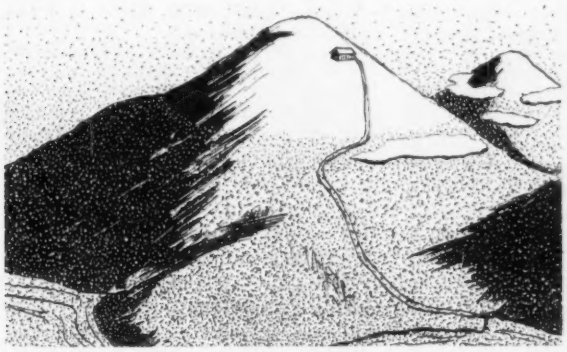
Because time on a $1.5 million computer is valued at about $300 an hour, it was pointed out that the new readout not only is convenient, but also can save large computer laboratories thousands of dollars.

Graphite "Welded" First Time in History

Two scientific achievements of world-wide significance were announced at the dedication of Union Carbide's multimillion dollar research laboratories.

Scientists have discovered, for the first time in history, how to "weld" pieces of graphite together, providing a new technique which promises great advances in the processing of materials necessary for the atomic age.

In addition, the largest single crystals of cadmium sulfide ever reported have been "grown" in the new laboratories. A light-sensitive material, cadmium sulfide can be



National Bureau of Standards Photo

MAUNA LOA VOLCANO drawing shows the new two-mile-high observatory about 2,500 feet below the summit. In this latitude moisture and dust (*indicated by dots*) are usually trapped below the 8,000 foot level by the prevailing trade winds.

National Bureau of Standards Photo

HIGH-ALTITUDE OBSERVATORY on the slope of Mauna Loa. Ideally located for astronomical and upper-air studies, the observatory is expected to provide valuable information in many scientific areas. The platform in the foreground and the tower at right are used in making observations.

used in photo cells, solar batteries, and when properly activated, as a light-producing phosphorescent material. It has been found that the photo conducting properties of single crystals are superior to those of a polycrystalline film, and laboratory crystals three eights of an inch in diameter and several inches long have been produced by newly-developed techniques.

Heated in special crucibles under high pressure to prevent vaporization, liquid cadmium sulfide is allowed to cool slowly. As it cools, a single crystal emerges, and takes its shape and size from the crucible.

A group of over 300 scientists, educators and industrial leaders from all over the United States spent the day inspecting the laboratory facilities.

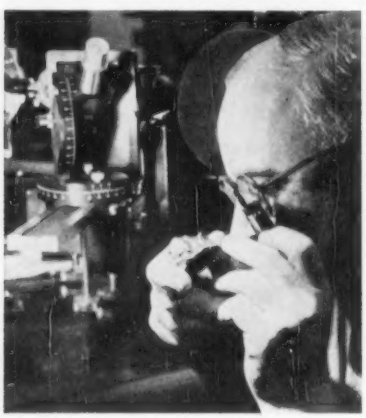
Pointing out the significance of welded graphite, Dr. R. G. Breckenridge, director of the Laboratories, said that it suggests the possibility of prefabricating sheets and panels for the assembly of nuclear reactor moderators which now must be built up from graphite blocks. Graphite is an essential material in nuclear reactors because of its neutron-slowing abilities which makes possible the self-sustaining chain reaction necessary in harnessing nuclear energy.

The background of research efforts to melt graphite was explained as follows:

Melting operations are used in well-known techniques for processing metals. In the case of graphite, which is one of the crystalline forms of carbon, however, it is not as simple. This is so because at normal pressures graphite does not melt when heated to high temperatures, but instead vaporizes directly into a gas. If heated under high pressure, however, vaporization is prevented and graphite can be made to melt. This is the key to the process.

Already this technique has led to the production of new forms of graphite which have a much higher degree of crystalline perfection than any artificial graphite obtainable up to now. In addition it has led to a method for welding pieces of graphite together, essentially a melting operation.

Pieces of graphite to be joined together are placed in an atmosphere of the inert gas argon under high pressure; the pieces are brought into contact, and a direct current is passed through them. The pieces are then separated slightly, creating an arc that heats the graphite to extremely high temperatures. This combination of heat and pressure melts the graphite and the pieces are welded together.



THE LINE between the shiny and dull regions in this piece of graphite is the place where two pieces were "welded" together at Union Carbide's laboratories. The graphite in the vicinity of the weld is very crystalline and of high quality.

A similar technique is used for a sort of continuous casting process, in which comparatively large pieces of graphite are formed from the liquid state. This graphite has a degree of crystalline perfection comparable with that of the best natural graphite, formed millions of years ago.

This is just one part of a broad program which has led to the production of other scientifically and technologically interesting forms of graphite, it was pointed out. Very fine filaments have been produced, resembling whiskers, having diameters smaller than $^1/_{10,000}$ of an inch. These filaments have exceptional tensile strength, perhaps as much as 10 times that of normal carbon materials, and the ability to withstand severe plastic distortion without breaking.

WEATHER: Test Chamber and Hurricane Inspector

A robot "Hurricane Inspector" has been built to sit through the worst storms dished up by open water up to 100 miles offshore in the Gulf of Mexico and report what happens inside them.

It is believed that the "Inspector" will be the first sleuth, either human or electronic, in marine history to measure scientifically the forces of waves, winds, tides, and currents in the open sea and in water depths over 100 feet.

Strangely enough, almost no exact data of this type exists. Previous research on these forces, by the U. S. Navy, U. S. Coast Guard, and U. S. Geodetic Survey, has been conducted chiefly in the shallow water along the shore line.

The complicated engineering mechanism has been created by Gulf Research & Development Company, a subsidiary of Gulf Oil Corporation, Harmarville, Pa., with the aim of learning the strength needed in offshore drilling platforms to protect the operating crews and equipment.

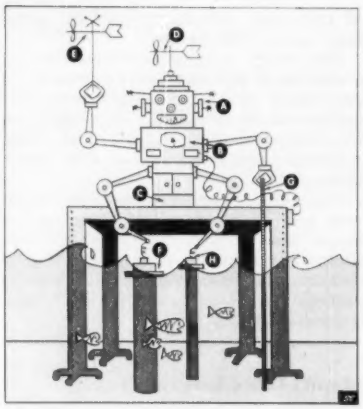
The design of these platforms is based now on the "hind-casting" method, developed during World War II to gauge beach landings. "Hind-casting" calculates future storm violence from past observations correlated with theoretical maximum sea forces in relation to depth and exposure of particular areas.

Although considered fairly reliable, no one knows for sure to what degree and in what direction "hind-casting" may differ from actual fact.

So a lot of treasured sea legends—and perhaps scientific theories, too—may go by the board when the "Hurricane Inspector" starts turning in its reports. It will check on those "100-foot waves" old salts like to describe, on the 60-foot wave scientists theorize can occur on the continental shelf once in 35 years, and on the maximum of 40-foot waves estimated by "hind-casting."

Many lives will be at stake in opening the great Gulf of Mexico oil frontier, where lies a large portion of the nation's unexplored petroleum reserves; the company intends to take no chances on tradition or theory.

Not new in the sense of being developed from the ground up by Gulf, the "Inspector" is a complicated adaptation of existing instruments. The problem was to unite them into a compact unit which would record and correlate many types of information.



MR. HURRICANE INSPECTOR (A) instrument and (B) recording cabinets; (C) 32-volt operating battery and (D) wind generator to charge it; (E) wind velocity and direction detector; (F) wave force detector and (G) step resistance gauge for wave height; and (H) mean water level detector.

Two heavy-steel, water-tight boxes, one about the size of a small household refrigerator and the other slightly smaller make up the unit. The whole is self-operated by a battery continually recharged by a wind generator. Moisture absorbers are included to keep the delicate instruments damp-free.

The boxes contain amplifiers, power units, connecting cables, sequence timer, timing marker, and two recorders for imprinting six channels of information on running chart paper correlated with the date, the hour, and the minute. Recordings will be taken automatically for two minutes each half hour.

The "Inspector" will record the height of waves, period between crests, and the tide during their occurrence. From this data wave length and velocity can be computed. A "wave profile recorder," in which insulated spark plugs momentarily short out as a wave passes over, will do the measuring.

Wind velocities will be noted by a wind-velocity–wind-direction indicator up to 100 miles per hour. Above that a wind gust indicator will take over.

Wave and current forces will be measured by two steel tube piles, one smaller than and standing inside the other. The outer pile will absorb the force, and the inner unaffected one will give a comparison. Electric strain gauges transmit the data.

The "Inspector" will run about 100 feet of chart paper every two weeks, at which time it is changed. All units of the device are separately replaceable, and "spares" are included, so a layman can keep them operating.

World's Weather in a "Box." An environmental testing chamber used to evaluate the effect of various weather conditions on airborne electronic systems has been installed at the Westinghouse Electric Corporation's Air Arm Division, in Baltimore, Md.

Considered as one chamber, the "box" actually consists of two sections 10 feet high,

18-feet wide, and 16-feet deep. In one, rain humidity and salt spray tests are conducted. In the other, altitude and temperature tests. In a matter of minutes the temperature can be reduced to a −100 F. Similarly, the temperature can be raised to a sizzling +500 F. This is done with one man operating the chamber from a set of controls.

Rapid temperature changes are made possible by heating and cooling a separately enclosed area above the chamber while other tests are in progress. Thus, when a rapid change is desired, "trap doors" in the roof of the chamber are opened, and fans circulate the hotter or colder air into the main section of the chamber.

In this section airborne electronic systems are "taken up" to altitudes as high as 80,000 feet in about 25 minutes. At an initial rate of 5,000 feet a minute, the chamber reaches an altitude of 50,000 feet in 10 minutes, slowing down on its way up to the 80,000 feet mark.

In the other section of the two-part chamber are the humidity rain-making and salt-water spraying devices. A standard test in this section would be run as follows. The item to be tested, a computer, for example, would be placed in the chamber at room temperature at a relative humidity of 95 per cent. The temperature would then rise to +185 F in two hours. After remaining at these conditions for 6 hours, the chamber would return to normal in the next 16 hours. The equipment would undergo this treatment for 10 consecutive days.

The entire chamber is fiberglass insulated. Walls and ceiling are made of stainless steel. The equipment required to create these artificial conditions, including compressors, steam generators, cooling systems, pipes, valves, and controls are "housed" beneath the floor of the plant in a specially excavated pit. A special two-foot thick, four-ton steel door moves down into the pit in front of the altitude chamber permitting "floor-level" loading of heavy electronic equipment.

Largest Man-Made Crystals Are Displayed

Mammoth man-made single crystals—the largest ever reported—of the elements germanium and silicon have been displayed recently. The monster jewel-like crystals, measuring about half a foot in diameter, are not mere laboratory curiosities, they have important uses in electronic equipment.

Both germanium (a rare element) and silicon (the second most common element) belong to the class of "semiconductor materials." Diamonds also fall into this class and the huge Texas Instruments Incorporated crystals are true precious jewels, with a perfection surpassing that found in nature.

Semiconductor materials, which have become economically significant only in the last decade, have two basic unique properties: (1) they can conduct electrons selectively, and (2) they are transparent to infrared radiation.

This first characteristic is applied to make the tiny, long-lived transistors. The second characteristic is proving valuable in the manufacture of new systems utilizing the infrared portion of the electromagnetic spectrum where radiation is invisible, yet displays optical characteristics.

Semiconductor crystals are grown by superpurifying the material (to about one impurity in a billion), inductively heating it to its melting point (with its temperature controlled to a tenth of a degree) in an inert atmosphere (hydrogen or helium). A "seed crystal" is inserted in the molten material when it is at the verge of "freezing" and a giant crystal is grown when the seed

Texas Instruments Inc.

RULER shows relative sizes of the two types of crystals which have been made by man.

is rotated, vibrated, and withdrawn simultaneously.

This precise process is a production line operation. Some two dozen crystal-growing machines are in daily operation, producing the semiconductor crystals used to manufacture transistors, rectifiers, diodes, and various other types of semiconductor products.

Electrified Cellular Concrete Floor with Fireproof Long Clear Spans

A precast structural concrete floor system with underfloor electrical distribution for office buildings was demonstrated recently. This system uses the hollow cells in Flexicore precast concrete floor blocks as electric raceways and provides electrical floor outlet spacing as close as $5^1/_3$ inches. It also permits installation of new outlets at any time in the future, at nearly any location on the floor.

In addition to providing electrical availability, there are two principal advantages to the system. The structural floor, being of concrete, requires no fireproofing, and its design permits clear spans of 20 feet without the use of intermediate beams.

The floor is electrified by metal feeder ducts which are installed on top of the structural floor in a $1^1/_2$-inch concrete fill. The feeder ducts run at right angles to and feed the cells in the floor which are continuous from one end of the building to the other.

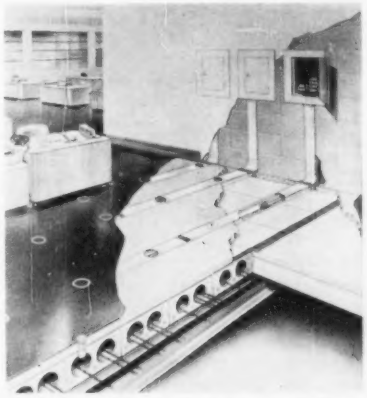
The system has the advantages of economy and fast installation. The structural floor is precast and requires no on-the-job pours of structural concrete, permitting high-speed construction on structural steel, reinforced concrete frame or masonry bearing walls. Wiring system fittings are prefabricated and installed quickly after slabs are erected.

Underwriters' Laboratories gives a 3-hour rating to a Flexicore floor of 8-inch × 16-inch slabs and $1^1/_2$-inch topping. Article *358* 1956 National Electric Code, entitled "Cellular Concrete Floor Raceways," covers use of this system. The 1956 Code was published in September.

Architects using Flexicore electrified floors report savings over comparable floor systems. The dry erection of the long-span, lightweight structural floors saves on-the-job labor. Less steel is required because of the long spans and over-all saving in weight. The fireproof qualities of the structural floor require less topping, usually $1^1/_2$ inches and a fireproof plaster ceiling is not required.

Conduflor electrical fittings are used on the system, and include feeder ducts, handholes, electrical, and telephone floor outlets and other fittings required.

The wiring runs from the panel box to the feeder duct, then along the feeder to a handhole junction where it drops into a cell in the flexicore floor. It then runs in either direction in the cell to an outlet. An outlet can be located at any point along the cell and can be installed at any time during the life of the building. Any number of systems can be installed; electrical, telephone, intercom, and any others desired.



FLEXICORE electrified cellular concrete floors combine with Conduflor electrical fittings to offer nearly unlimited electrical availability.

Both cells and feeder ducts have ample dimensions. Cells are $4^1/_8$ or $6^1/_8$ inches in diameter depending on slab size. Width of the feeder duct is 4 inches; depth varies from $1^1/_2$" to 2 inches, and feeders with depths up to 4 inches are available for unusual conditions. Handhole junctions between feeder and cell are $2^3/_4$ inches in diameter and the handhole in the finish floor is $3^1/_2$ inches in diameter.

Heart Disease May Be Defeated by Computers

High-speed electronic computers used by Lockheed Aircraft Corporation scientists to solve guided missile problems today are working to defeat the nation's number one killer—heart disease.

The computers, located at the company's Missile Systems Division, Van Nuys, Calif., spend their spare moments between missile

calculations in a fantastically detailed new study of the human heart's activity. This study promises to reveal extensive new knowledge of heart diseases, their earlier detection, and relief.

The heart studies are a co-operative effort by the division and Dr. Travis Winsor, eminent Los Angeles, Calif., cardiologist and director of the Nash Cardiovascular Foundation at Good Samaritan Hospital in Los Angeles. The company is making available its IBM *650* computers, largest battery of such machines outside IBM itself, for the cardiac computations.

The electronic "brains" make it possible for the first time to analyze, rapidly and accurately, the human heartbeat in terms of "harmonic content." Lockheed technicians in the program explained that the heart's total activity is made up of many contractions, flutters, valve actions, and other motions. Harmonic content is the combined frequencies (rates of occurrence), and amplitudes (high and low points of each occurrence cycle) of these many heart motions.

In the program's new harmonic analysis method, the computers make it possible to describe and record in precise mathematical terms all of the heart's activities. With this information, the researcher can distinguish much more accurately between normal and abnormal cardiac conditions.

Dr. Winsor said that the use of such electronic equipment is the first major advancement in the accurate compilation of heart data in 50 years, and that the Nash–Lockheed program is one of the few co-operative industry–medical heart studies in the nation.

Present heart studies at the Nash Foundation center primarily around hardening of the arteries and high blood pressure and their effects on the circulatory system.

In their pioneering departure from standard methods, the heart researchers have adapted the oscilloscope, an instrument used widely in the missile and electronics industry. Electrodes attached to the patient's body carry minute electrical impulses to the instrument which presents them visually as a wavy line. The scope—much like a television picture tube—allows researchers literally to "see" the fleeting heartbeat.

They take carefully timed photographs of the heartbeat wave as it sweeps across the face of the scope. Enlarged photographs of a portion of the heart pulsation—covering only 1/10 of a second—are segmented into approximately 80 points from which the harmonic content is determined.

This step replaces the usual electrocardiograms, which do not produce sufficiently detailed tracings for these refined studies. The electrocardiograms also do not furnish precise definition between normal and abnormal heart conditions, so that in certain instances it is difficult for the specialist to determine whether a patient has heart disease.

Tabulations produced by other equipment quickly show any deviation in the patient's heartbeat when compared with former records.

Applications of Dr. Winsor's techniques already are being made to determine success or failure of certain cardiovascular operations, to follow results of corrective treatment, to measure the success of artery grafting operations, and to show when blood clots are completely removed from arteries.

Blue-Baby Condition Detector

An electronic device, which facilitates diagnosis of blue-baby conditions and other cardiac diseases, has been introduced by The Colson Corporation, Elyria, Ohio.

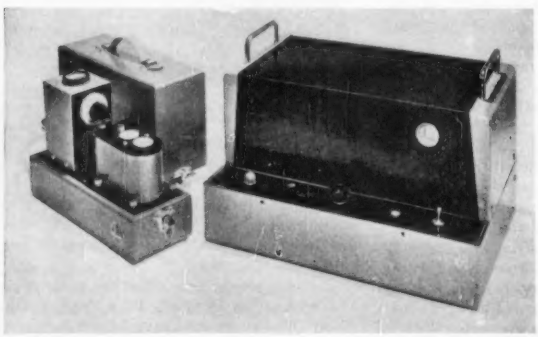
R. A. Pritzker, president of the firm explained that the device—a cuvette densitometer—is an optical instrument which gives the physician continuous information on variations in the oxygen saturation of blood taken from specific regions of the heart through a catheter. The catheter, a thin plastic tube, previously has been passed into the heart through an arm vein.

By ascertaining the position of the catheter in the heart by X-ray, the physician can determine the positions in the heart at which the patient's blood departs from the normal oxygen saturation.

Blue-baby conditions can be caused by several different malformations of the heart, its valves, or the blood vessels feeding into or carrying blood from it. The location of the specific region of the heart, where oxygen saturation of the blood departs from the normal, is an important key to the diagnoses of the malformation. The physician must have specific information on the location of the malformation in order to implement corrective surgery.

Determination of oxygen saturation is now mainly done on blood samples removed by catheter and later taken to the laboratory for analysis.

With the cuvette densitometer the blood flows directly from the catheter through the instrument, giving the physician a running account of oxygen saturation as he moves the end of the catheter to various areas in the heart.

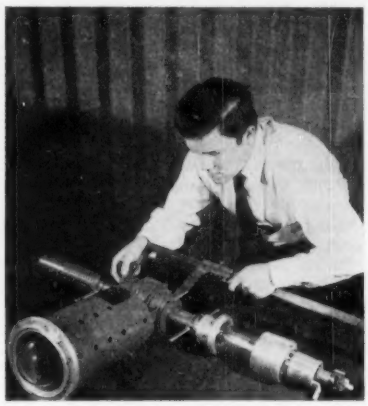


BLUE BABY conditions and other cardiac diseases can now be diagnosed with great facility with a new cuvette densitometer.

Longest Range Shipborne Radar

The most powerful shipborne radar set ever put in service has been installed on the cruiser *USS Northampton*, a United States Navy command vessel for directing the firepower of a task force.

At the heart of this most powerful radar



Westinghouse Photo

AT THE HEART of the longest range shipborne radar ever put in service is an ultrapowerful magnetron nicknamed "Big Maggie," which delivers 10 mw of power.

set is a magnetron designed and developed by the Westinghouse Electronic Tube Division, Elmira, N. Y. Nicknamed "Big Maggie," this tube delivers to the radar antenna the powerful pulses of r-f energy which can search out enemy planes over 400 miles away. At peak power, Big Maggie delivers over 10 million watts, as much electric power as is normally required by a city of 25,000 people.

This increased range and power means that interceptor planes will have more time to get into the air, especially important in this era of high-altitude, high-speed aircraft.

"Operation Maggie" started in 1947 when the Navy, foreseeing the imminent need for long-range radar in fleet and home based operations, sponsored the tube development. The goal was a magnetron whose power capacity was at least 10 times that of existing World War II magnetrons.

One of the major technical problems faced in this new tube development was to generate long pulses of extremely high power in a volume about the size of a football.

Another major technical problem was the development of a cathode that could supply the enormous electric current required. The cathode had to operate at temperatures up to 3,100 F, greater than the temperature of molten iron from a blast furnace. Inasmuch as no existing cathode material could operate at the power levels generated by Big Maggie, new alloys and fabrication methods were pioneered. New design approaches such as transparent vacuum-tight portholes to allow the release of radar waves were the result. In this instance a special glass window, saucer-size but very thin, had to be developed to withstand the intense heat from the cathode and total pressures as great as 400 pounds. The new

magnetron operates as a sealed oscillator, employing water and mild forced-air cooling.

An accomplishment in itself is the power supply for the magnetron. It must supply peak input power pulses of about 23 mw at 60,000 volts. Testing equipment for evaluating the tube was another project requiring major engineering effort.

After successful laboratory tests in 1953 Big Maggie and its associated equipment underwent performance tests in the port of Boston, Mass. First tests surpassed expectations for distance-scanning; radar operators monitoring a radar screen aboard a warship were said to be surprised when, to the south, they could observe air traffic arriving and leaving New York City's La Guardia Airport, and to the north, the rugged coastal terrain of Nova Scotia.

Color Bulbs Change Home Decor with Light

A totally new concept of home lighting was unveiled recently when General Electric's large lamp department introduced a line of colored light bulbs designed to create a variety of atmospheres with tinted light.

Definitely pastel-colored in appearance when unlighted, the new bulbs produce a soft, tinted light when turned on. They give an impression of a color tone in a room, enhancing existing colors in draperies, furniture fabrics, walls, and complexions.

The new bulbs are made in popular household sizes and come in "Sky Blue," "Spring Green," and "Sun Gold." Together with the existing pink lamps, which have been renamed "Dawn Pink," they will be known collectively as "Coloramic" lamps.

It is simple for the homemaker to achieve dramatic decorative effects, to literally paint with light. The home can be given increased interest by developing varied delicate color contrasts from room to room with the lighting effects made possible by these new "Coloramic" bulbs. No other form of decorating can be done so simply and at such a low cost.

The *Sun Gold* lamp is "luminous, radiant, warm, and soft, like the sunset. It suggests the tone of vast, waving, ripe grain fields."

The *Dawn Pink* is "rosy, warm, soft and like the tinted early morning clouds. It suggests warm skin tones of a lovely complexion."

The *Spring Green* is described as "mildly cool and verdant and soft. It suggests the new season and new foliage."

The *Sky Blue* is cool and soft. "Its rosy overtones step out from people's faces to create a new warm glow. All reds are brought to life, even though the light has bluish overtones."

The new "Coloramic" light bulbs can be used anywhere in the home. Too, they offer clubs, lounges, hotels, and restaurants a new means for creating the type of atmosphere most suitable to their clientele.

Colors used in the new "Coloramic" line were selected after months of research in G. E.'s Nela Park lighting laboratories. They were chosen to work well with a wide variety of colors and color schemes. Special attention was given to their effect on complexions. Color-tinted light produced by the new bulbs is achieved through use of a permanent enamel baked on the outside.

Remote Control Runs One-Man Television Station

A low-cost, low-power completely remote controlled television station which is operated with a staff of only one technician per shift may hold the answer to the economic problem of small-town television.

The first such installation in the nation has been in operation at KSHO-TV (150 watts) for the past six weeks on a 24-hour per day schedule. First in the nation to operate on an around-the-clock schedule seven days a week, KSHO-TV is transmitting live shows and film programs to residents of Las Vegas and Henderson, Nev.

The station has a crew of only four technicians—one for each shift plus a chief engineer. All equipment, including cameras, are remote controlled from a small master console. The operator can change focus and lenses on the cameras, start and stop the film chain, adjust the lights, monitor and switch audio circuits, adjust picture quality, and perform the other technical work that, in high power stations, requires crews of a dozen or more men.

KSHO-TV is equipped with three Kay Lab (San Diego, Calif.) model *1985 B* camera chains: one live studio chain, one remote-controlled live chain, and one film chain. A master console containing all of the remote controls is the heart of the operation.

Operating with 150 watts power, the station has an effective radiated power of 436 watts, transmitted through a 4-gain antenna 240 feet above ground, from atop the 15-story Hotel Fremont in Las Vegas. The signal is fed into the antenna system through a 400-foot line.

Primary coverage area is a radius of 15 miles. Programming is both live and film, with emphasis on the latter in six-hour blocks.

KSHO-TV has solved the problem of maintenance by installing two transmitter units, which are used alternately. In practice, the shift technician's time is taken up in large part with threading film projectors and loading slide projectors.

The low-cost ($70,000), low-power package has exciting possibilities for educational television. Cost of installation and operation is well within the realm of possibility for many city school systems that have been frustrated by the high cost of installing high-power stations.

Trinidad Port of Spain Power Station Extension

The Port of Spain power station of the Trinidad and Tobago Electric Commission opened its 10-mw extension on November 17, 1956.

The original installation at Port of Spain, one of the three power stations owned by the Commission, had a capacity of 21,700 kw. The extension increased this to 31,700 kw, which will be an aid in furthering the ability of the Commission to supply electricity which is cheap, reliable, and abundant, on a commercial basis throughout the island.

The Commission generates the public supply of electricity for the island. It sells electricity in bulk to the Port of Spain Corporation Electricity Board for distribution in the city and to the Borough of San Fernando for distribution in the Borough. Elsewhere in the colony, the electricity is sold directly to the customer.

In the island of Tobago, the Commission supplies electricity in Scarborough and its environs from a small diesel installation of 550 kw.

At Penal, in South Trinidad, there is a generator of 10,000-kw capacity. A 20-mw steam turbo alternator is being installed to supplement the present installation, which will be ready by 1957. Natural gas is the fuel used at Penal.

To install the turbo alternator, a 60,000 pounds per hour boiler was built to which a 175-foot chimney was connected. The 13,400-hp turbo alternator generates 10 mw.

Sir Edward Betham Beetham officiated at the plant opening on Wrightson Road.

Fuel Cell Studied at New Laboratories

The fuel cell, a battery that produces electricity from such gases as hydrogen and oxygen, is one of the many new devices under study at the new Parma, Ohio, basic research laboratories of National Carbon Company, a Division of Union Carbide and Carbon Corporation.

Where ordinary batteries utilize energy obtained from metals and other substances in the form of charged particles, recent research indicates the possibility of making a battery which will obtain its energy, its supply of charged particles, entirely from gases such as oxygen and hydrogen.

A possible version would include two basic unit sections. One section would consist of layers of porous carbon and a liquid-paste caustic solution with a space between. Oxygen gas would stream into the space, and its molecules would move through the submicroscopic tunnels and channels in the porous carbon.

When the molecules reach the caustic layer they form a film, and reactions take place which produce negatively charged particles. This is the electron-consuming or "positive" section of the battery. The other section, the electron-supplying or "negative" unit, is constructed in a similar fashion. It makes use of a stream of hydrogen gas which reacts to produce positively charged particles.

Fuel cells will operate continuously, providing steady electrical currents as long as oxygen and hydrogen are fed into them. They have many potential applications. For example, they would furnish auxiliary power in chemical plants where these gases are by-products of commercial processes. Fuel cells could also be used as power supplies for light buoys and remote stations.

Air Force Announces Avionic Operational Equipment

The United States Air Force has announced the delivery of new and improved electronic close-support ground guidance radar to operational elements. This close support control set, called the *MSQ-1A*, was designed and built by the Reeves Instrument

Corporation, a subsidiary of Dynamics Corporation of America, at a cost of approximately $40 million.

The Air Force indicates that the *MSQ-1A* system consists of three basic vans—radar, computer, and communications. The radar van tracks friendly aircraft and furnishes continuous data to the computer van for evaluation. The computer van analyzes, interprets, and issues all necessary command instructions for guidance or tactical operations of the aircraft. In addition, it provides a continuous plot of the location of any and all airborne weapon systems. Proper functioning of the system can be checked by using a series of built-in automatic test problems.

Since close-support combat situations may occur anywhere in the world, under all kinds of climatic conditions, the system has been climatized for world-wide operational use.

The *MSQ-1A* is the newest in a series of Close Support Control systems developed for the Air Force, and is the only one which is air-transportable. One of the earlier *MSQ* systems was used as a ground radar station during the March 1955 atomic tests at Frenchman's Flat, Nev., to precisely position pilotless jet planes for the atomic blast at a predetermined time and location.

Free Flight Research Tool Gathers Hypersonic Speeds Data

The Air Research and Development Command (ARDC) has announced the development of a research rocket that reaches nearly seven times the speed of sound in just two seconds. Called the Hypersonic Test Vehicle (HTV), it has been developed as a free flight research tool to gather data at hypersonic speeds.

The first Air Force HTV developed by Aerophysics Development Corporation, Santa Barbara, Calif., in conjunction with ARDC's Wright Air Development Center (WADC) is now near standardization. Fifteen experimental HTV models already have been fired and tested at ARDC's Holloman Air Development Center, Alamogordo, N. M.

The HTV is a two-stage solid propellant rocket vehicle. The first stage is a booster which accelerates the second stage. After the first stage burns out, it falls away and the second stage ignites and reaches the maximum velocity of nearly seven times the speed of sound. It is with this stage that the hypersonic data is gathered. This data includes information on aerodynamic heating, aerodynamic shapes, and air pressures.

PENETRATING the "thermal barrier," the hypersonic test vehicle is shown leaving launcher a fraction of a second after firing.

Eleven solid propellant rockets power the HTV. The first stage consists of seven rockets and the second stage consists of four WASP I rockets. The first stage is five feet long, nine inches in diameter, and is equipped with three laminated glass fiber fins which stabilize the rocket in flight. The second stage is five feet long and six inches in diameter, has four laminated glass fiber fins for stabilization, and is topped with a two-foot nose cone.

The nose cone is instrumented with a magnetic tape recorder. This device charts rocket acceleration, temperatures and pressures on the nose cone as the rocket travels at hypersonic speeds.

In operation, the HTV is fired from a 16-foot long portable launcher. All seven of the first stage rockets are ignited simultaneously. These rockets burn out and the first stage falls away.

This separation causes the four second stage rockets to ignite and accelerates the second stage to its maximum velocity.

The second stage continues coasting until its fins are intentionally blown off by small charges within the rocket. This occurs about six seconds after the rockets burn out, and causes the rocket to lose its stability and tumble to earth.

The HTV nose cone configuration, dimensions, and composition may be changed, and the effects of these changes in relation to hypersonic flight may be studied. This will provide the Air Force with hypersonic research data on aerodynamic shapes, aerodynamic heating, rocket stability, and air pressure distribution.

Nuclear Reactors for U. S. and Foreign Research Installations

Japan. Fabrication has begun on the nuclear research reactor designed for the Atomic Energy Research Institute of Japan.

At the same time, instruments, parts and materials for the reactor are being procured following completion of the final design.

The 50-kw "solution type" reactor, so termed because it will use as "fuel" enriched uranyl sulphate dissolved in about four gallons of water, will be similar to the industrial research reactor designed and built for the Armour Research Foundation.

The reactor for Japan has a unique design to prevent the discharge of any radioactive gases or other fission products into the atmosphere. The gases will be retained inside the primary system where they are circulated and recombined. This has the added advantage of providing a source of neutron-free gamma rays, essential in medical and scientific research.

The "heart" of the reactor will be an elongated stainless steel sphere about a foot in diameter called the "core." Here atomic fission, the "splitting" of atoms, takes place, producing heat and releasing gamma rays and neutrons (*Electrical Engineering*, October 1956, p. 958).

The Atomic Energy Research Institute of Japan, a nonprofit foundation sponsored by the Japanese Government and industry, will use the reactor in several areas of nuclear study including medical research, drug sterilization, food preservation, production of radioisotopes, and research and study in reactor techniques.

To be located near Tokyo, it will be the first reactor for the Far East when completed in early 1957.

Netherlands. An order for a 20,000 kw test reactor, the largest ever sold commercially, has been received by the Nuclear Energy Products Division of ACF Industries, Incorporated.

The reactor, to be built for the Netherlands Reactor Center, will have a power rating twice the output of any previously announced research nuclear energy device sold commercially.

According to the Netherlands interests, this pressurized-water materials-testing reactor is a new type. A prototype model is now being constructed at Oak Ridge National Laboratory. The Netherlands reactor will be fabricated by several different product divisions of ACF under supervision of the Nuclear Energy Products Division, and is to be erected in Holland.

Massachusetts Institute of Technology. A heavy-water research reactor of the Argonne National Laboratory *CP5* type is under construction for the Massachusetts Institute of Technology (MIT).

The MIT installation will be used for training students in nuclear engineering and for research in such fields as medical therapy, solid-state physics, sterilization of food, biology, testing of industrial materials, and engineering of future reactors. It will be operated initially at 1,000 kw, but is designed for ultimate operation at 5,000 kw. It will be the first reactor erected in New England.

Italy. A 5,000-kilowatt reactor of similar *CP5* type is being built for the Italian National Committee for Nuclear Research. The unit being built for Italy is the first research or test reactor to be sold abroad. A physicist and two engineers from the Italian National Committee are now working with ACF on matters of design at Nuclear Energy Products' new quarters in Washington, D. C. It will be fabricated in this country and constructed at Milano University in Italy.

Canadian Post Office Uses Electronic Sortation System

A Canadian-designed machine that will sort post office mail into any one of 10,000 pigeon-holes at a speed of 10 letters per second goes into operation at Ottawa, Ont., Canada, early in 1957, according to Dr. Maurice Levy of the Post Office Department.

Employing the basic principles of computers, the sorter's electronic eye will read coded symbols printed on all mail for subsequent handling by an electronic brain coupled to mechanical parts which do the actual sorting. The one brain will accelerate the 10 letters per second sorting rate as much as 5 to 10 times, achieving the end result of quicker mail deliveries across Canada.

The manufacture of the first machine—to be set up in Ottawa—for automated mail

handling culminates three years research by Canada's Post Office Department. By a code system which prints only four symbols on letters passing on a conveyor, the sorter's electronic eye is able to direct the mailed piece onto the next lap of its automation journey to the electronic sorting brain.

The four symbols are printed on the envelope by operators who, with a few weeks' training, can feed the machine at a high machine rate. Their fingers, punching out the four symbols, represent the only manual sorting operation involved from the time the letter enters the sorting department until it leaves in the carrier's bag.

A further application of electronics, already through its experimental stages, enables the machine to pick every envelope from a pile of jumbled incoming mail and pass it right-side up to the operator.

The coding stage of the sorting operation can be done in one big city so that the mail, on arrival in another big center, is ready for the electronic unit there to finalize the sortation for local street delivery or for onward transit, effecting a considerable saving of time. The mail arriving in this manner is ready for street delivery almost at once.

The problem will be surveyed by W. J. Turnbull, Deputy Postmaster General and Dr. Maurice Levy. It is also expected that an actual demonstration of some components of the machine will be shown at the Institute of Radio Engineers Exposition running concurrently with the IRE Convention in Toronto.

The fundamentally simple principles built into the electronic sorter eliminate the need for the highly specialized memories of manual sorters. By coding the four essentials—province, town, street, and number—for the the electronic eye to scan, the human brainwork with its possible errors is dispensed with. Then, by controlling the mechanical parts with an electronic brain, the physical action in sorting, with further possible mistakes, is eliminated also.

Defense Department Electronic Test Center

The Department of Defense has established a center at New York University (NYU) for monitoring electronic test equipment, research and development throughout the country, it was announced recently by Dr. H. K. Work, director of the Research Division of the College of Engineering.

A team of NYU research engineers will serve as the staff for the Electronic Test Equipment Co-ordination Group, an agency of the Office of Assistant Secretary of Defense for Research and Development. The 20-member Co-ordination Group visited the new facility for the first time on September 17 and later held a meeting.

The NYU team will continuously study test equipment research and development throughout the electronics industry and the armed services. Other tasks include:

1. Provide technical assistance for the analysis and evaluation of proposed and current electronic test equipment projects.
2. Spot new laboratory advances and scientific trends here and abroad that may be worth full development.
3. Anticipate future needs for certain equipment, and initiate research to meet those needs.
4. End unnecessary duplication of effort by complete reports on industry- and service-wide developments.

Test equipment is one of the largest single areas in the electronics industry. Test equipment is sometimes more complex and costly than the end-item that it serves. A radar transmitter is an end-item; radar set echo boxes are test equipment.

Test equipment includes volt meters built for a few dollars, and multimillion-dollar instrument ranges for guided missiles. It is also used in nearly every scientific research field. The most common electronic test device is the cathode ray oscilloscope, that shows on a screen changes in electric current or voltage. It is used by researchers from acoustics to zoology.

Now a key tool for scientific measurement, its significance may be judged by the statement of Lord Kelvin 70 years ago: "When you can measure what you are speaking about . . . you know something about it; when you cannot . . . your knowledge is meagre and unsatisfactory."

According to D. M. Goodman, NYU engineering scientist who directs the new program, the electronic test equipment industry has grown more than 15 per cent annually since 1947, as against an average 3 to 4 per cent growth for American industry.

The current program at NYU arose to fill the need for a central active repository of information on today's rapid developments in electronic test equipment. The armed services, continually buying equipment and initiating research on equipment to serve new tasks, would find such a clearing-house particularly helpful.

This marks the second major electronic coordination group in the NYU Engineering Research Division. Since 1949, NYU has provided the secretariat for the Department of Defense Advisory Group on Electron Tubes, which monitors the art and progress of tubes and transistors. (A third major group, concerned with electronic parts, is located at the University of Pennsylvania.)

In addition, NYU research engineers have done research and development of several pieces of advanced test equipment in recent years. These include a transmission measuring set for measuring power in the frequency range from 100 kilocycles to 10 megacycles; a microwave impedance bridge to measure and automatically display complex impedances over a broad frequency range; radio frequency signal seeking receivers, and piezo-electric crystal measuring devices.

The new team has started with a comprehensive study of all available commercial test equipment. Later there will be a split-up into five working groups for the following classes of equipment: power and impedance measuring; frequency, time, and wave form measuring; signal generating; voltage and current measuring; and miscellaneous.

Later, the team will compile a main information index, according to these categories and will cross-index under power range (at 1,100-, and 1,000-watt levels), frequency range (direct current, audio, ultrasonic, UHF, VHF, etc.), and physical configuration (wave guide structures, coaxial structures, or ordinary nontransmission line systems).

Their information will be drawn from such sources as industry, research laboratories, military and nonmilitary Governent agencies, domestic and foreign technical publications, technical and scientific conferences, personal visits, and, whenever necessary, equipment research directly by the group itself.

In the United States alone, electron-tube production is measured in the billions. Besides beaming sound and sight into the living room and assuming top-level tasks in the laboratories and plants of industry, the electron tube is an indispensable tool in modern defense.

Co-ordinating research and development of every electron tube and semiconductor device used by the armed forces is the Defense Department's Panel on Electron Tubes. Because members of this group—representatives of the military services and Government agencies, and consultants from private industry and universities—meet on a part-time basis only, their work is co-ordinated in this nerve center.

Physicist Honored

Official ARDC Photo

COL. TAYLOR DRYSDALE, U. S. Air Force mathematician and physicist with the Air Research and Development Command, has been chosen assistant manager of the 1956 Olympic Swimming Team. Col. Drysdale, a former Olympic swimmer, held eight national and world titles. In 1954, he was awarded an oak leaf cluster to his Legion of Merit for the development of a revised U. S. nuclear stockpile composition, which provided a ninefold increase in U. S. firepower.

ARDC To Study Super Permanent Magnets

A new magnetic material which promises to yield powerful permanent magnets is under study for future use by the Air Research and Development Command (ARDC). The material was perfected as the result of a new and improved method for the preparation of highly purified manganese-bismuth in powder form.

The Westinghouse Electric Corporation carried out the major research under the leadership of Dr. Clarence Zener, acting di-

rector of research. Dr. Zener stated that the superlative magnetic properties of pure manganese-bismuth have been predicted for several years, but until now the pure form could not be attained.

The new method gives, on a laboratory scale, a highly magnetic form of manganese-bismuth. It produces this new magnetic material directly, in a high state of purity.

Perhaps the greatest advantage from the new manganese-bismuth magnets is their unusual resistance to demagnetization. The magnets are at least 10 times better in this respect than most commercial magnets.

This resistance to demagnetization, which comes from a magnetic property called "highly coercive force," suggests many advantages. Such magnets would not be adversely affected by external magnetic fields.

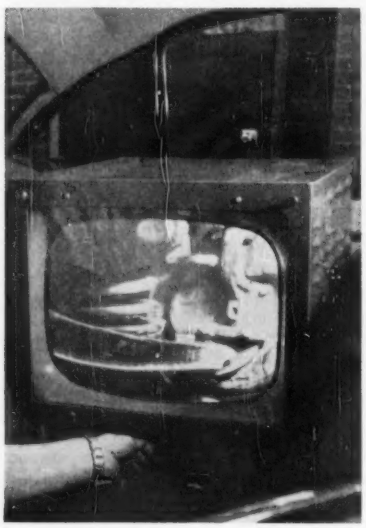
The high coercive force of pure manganese-bismuth could result in a whole new assortment of permanent magnets having novel shapes and uses. With this material, it is practical to make permanent magnets in a wide variety of shapes, particularly in the form of thin wafers or disks.

The super-pure manganese-bismuth is prepared in this way: Manganese and bismuth are ground together to extremely small size under an inert atmosphere of helium gas. Purpose of the helium atmosphere is to prevent the powdered materials from catching fire spontaneously.

The mixture is then sealed in a glass vessel under low-pressure helium. Using precise temperature control, the manganese and bismuth are then caused to unite chemically at a temperature slightly less than 520 F—the melting point of bismuth. The resulting product, virtually 100 per cent pure manganese-bismuth, is then reground to a fine powder. These particles are then imbedded in a plastic matrix, orientated in a powerful magnetic field and molded to shape.

Television Test of Automobile Suspension System

A small, rugged, bomb-shaped television camera gives General Motors engineers a picture of what goes on underneath an automobile when it is cornering sharply or bouncing over a rough test road.



The picture is transmitted through a closed television circuit to a 14-inch monitoring screen in the rear of the test car.

This mobile television system, used for the first time in automotive research, was developed at General Motors (GM) Technical Center by GM engineering staff's test facilities group in co-operation with a television camera manufacturer, General Precision Laboratory, Pleasantville, N. Y.

Engineers believe it is the best system for quick answers in test work. Ordinarily they would use motion picture cameras for such visual aid in testing, but working with film is slower.

For watching the action of a car's suspension system, a television camera is attached to the underside of a car's front or rear bumper and focused on the portion of the suspension engineers wish to observe.

When the test is under way, an engineer observer sits in the back seat of the car and watches the remote action going on beneath.

It is likewise possible to use such a system with the picture flashed to a large screen in an office or laboratory where a group of engineers can sit and watch the action on a car cruising along a test road miles away.

In addition to testing suspension systems in action, engineering staff men also have used the mobile television unit for observing tire roll when a car is going around a corner.

In other tests a television "eye" has been mounted beneath a car's hood. This helps them to observe engine "rock," fan blade "bending," or action of throttle and choke controls.

Instrument Developed for Faster Analysis of Jet Age Stresses

Faster and more accurate analysis of men who have to stand the stresses of the jet age may be implemented with a new instrument developed recently by Air Force research personnel and the mechanics research department of American Machine and Foundry Company (AMF).

The instrument, which was developed at the Aero Medical Laboratory of the Air Research and Development Command's (ARDC) Wright Air Development Center (WADC) and at AMF, is a device which interprets the information presented by another instrument long used by the medical profession—the electroencephalograph. The latter is a sensitive electronic instrument which detects and records human brain waves that can be analyzed for brain damage, tumors, epilepsy, and other malfunctions.

BOLTED to the underside of test car's front bumper is television camera which "observes" action of car's suspension system. Picture from camera appears on a monitor screen in the back seat of the car, where an engineer can observe it.

The AMF instrument for analyzing these brain waves represents a different approach to the problem of automatic electroencephalograph analysis which the Aero Medical Laboratory feels may be superior to present methods of automatic analysis.

Working jointly, Aero Medical and AMF researchers are attempting to establish a mathematical basis for the characterization of brain waves. The instrument—called a Period Analyzer—is being developed and built to implement the mathematical theory.

The data which is developed by the Period Analyzer has proved to be a sensitive measure of certain physiological changes which affect the shape and frequency of the brain waves. In addition, the analyzer reduces the original data to one fifth of its original bulk, which often was as much as 300 feet of tracings on paper. Although still in the experimental stage, the use of the new instrument appears more sensitive than present techniques in distinguishing degrees of sleeping and wakefulness in subjects. It also can correlate the brain wave pattern with deficiency of oxygen in the blood more precisely. This may make possible the development of a device which corrects this condition in pilots by automatically switching on oxygen when a deficiency exists.

United Nations Facts and Recommendations

Transport of Dangerous Goods. Recommendations aimed at world-wide uniformity in the transportation of dangerous goods and at facilitating internal trade in such goods have been made by a United Nations (UN) Committee of Experts at a meeting held in Geneva, August 16 to September 12, 1956.

In a report to the UN Transport and Communications Commission, which will meet in New York in January 1957, the experts have recommended the establishment of a permanent governmental organ, within the framework of the UN, to work with the administrations and organizations responsible for regulations of an international character in this field. The new body would keep up-to-date lists of dangerous goods; prepare a system of code numbers for such goods; undertake the task of standardizing the regulations governing packaging; and suggest appropriate labelling.

The Committee of Experts has also recommended a system of numbering for dangerous goods that would obviate the difficulty due to different names for goods in different languages. Other committee proposals cover classification and definitions relating to classes; lists of principal dangerous goods and assignment of each of them to a proper class; labels identifying the risk graphically without regard to the printed text and shipping papers covering dangerous goods.

Statute of International Atomic Energy Agency. Eighty-seven governments have been invited to meet at United Nations Headquarters, New York, N. Y., beginning September 20 to lay final plans for a new international agency designed, in the words of its pro-

posed constitution, to put atomic energy increasingly to work for "the peace, health and prosperity of the world."

They will participate in a conference sponsored by 12 governments which have been negotiating toward the creation of the atoms-for-peace agency first proposed to the United Nations General Assembly by President Dwight Eisenhower of the United States on December 8, 1953.

Following his proposal for an agency to be set up "under the aegis of the United Nations," the General Assembly twice expressed hope that the organization would be established "without delay."

A draft statute was agreed upon at a working-level meeting held in Washington, D.C., by the 12 negotiating governments: Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Portugal, the Union of South Africa, the USSR, the United Kingdom and the United States.

"Atomic Energy for Peace, Health and Prosperity" was the text before the conference on September 20.

The agency was to be authorized, among other things, to encourage and assist in activities toward that goal and "make provision . . . for materials, services, equipment and facilities to meet the needs of research on, and development and practical application of, atomic energy for peaceful purposes, including the production of electric power, with due consideration for the needs of the underdeveloped areas . . ."

The agency is to foster the exchange of scientific and technical information on the peaceful uses of atomic energy; and encourage the exchange of scientists and experts.

It is to establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities and information made available by the agency, or with its aid, are not used to further any military purpose.

The 23-article statute also dealt with membership, organization, the supplying of atomic materials and other projects, safeguards, finance, relationship with other organizations, and other administrative matters. An annex to the draft provided that a Preparatory Commission would come into existence on the day the statute was opened for signature. The Commission, the annex states, will be composed of the 12 sponsoring states and six other states to be chosen.

The draft text specifies that the statute will come into force when 18 states have deposited ratifications, provided that the 18 include three of the following states: Canada, France, the United Kingdom, the USSR, and the United States.

The draft statute itself also contained a provision regarding the agency's relationship with the UN. It stipulated that the agency should submit reports on its activities to the UN General Assembly, to the Security Council when appropriate, and to other UN organs on matters that are within their competence.

Exhibit Commemorating Geneva Conference at UN Headquarters. An exhibit to serve as a permanent reminder of the historic significance of the first atomic conference held at Geneva last summer was on display at UN Headquarters during the conference convened on September 20 for the purpose of establishing a new atomic energy agency.

The exhibit, which stemmed from a proposal by UN Secretary-General Dag Hammarskjold, was intended to commemorate the first International Scientific Conference on the Peaceful Uses of Atomic Energy, which brought together 1,428 delegates and scientists from 73 nations, as well as 1,334 observers and will be a permanent addition to UN Headquarters.

Noting a widely felt feeling that it would be appropriate to commemorate the first atomic conference "in some tangible and symbolic form," the Secretary-General proposed that this commemoration "might take the form of a small exhibit placed on permanent display at United Nations Headquarters," which would serve "as a suitable permanent reminder of this memorable Conference."

Models were displayed in the north end of the lobby in the Secretariat Building.

The Canadian donation to the exhibit included a model of a uranium fuel rod from the *NRX* reactor. This reactor, located at Chalk River, Ont., is used to produce isotopes and as a source of radiation for nuclear research. The fuel rod is the one exhibited last year at Geneva.

France donated a model of the *G-1* reactor which is located at Marcoule. This reactor, cooled by air, has as its major function the production of plutonium. It is a forerunner of future nuclear power plants being developed in France. It was first operated last January.

Norway's part of the exhibit was a model of the *JEEP* reactor at Kjeller, Norway. This reactor is operated by the Joint Establishment for Nuclear Energy Research (JENER), a joint project of Norway and the Netherlands. A chain reaction was achieved in this machine in 1951. While the reactor was designed and is used primarily for research in the nuclear field, the 300 kw of heat it produces are utilized to heat the laboratory in winter.

The USSR portion of the exhibit had three parts: a model of the nuclear power plant near Moscow that has been operating for more than two years, a second model of the portion of the plant where the turbine-generators are housed, and a schematic chart of the operation. This plant produces 5,000 kw of electricity; motion pictures of its operation were shown during the conference in Geneva last year.

The United Kingdom donated a model of the first full-scale British nuclear power station at Calder Hall. One of the two reactors in this power plant is already running on a trial basis. This nuclear power station is supplying over 50 mw of electricity to the national grid.

The United States donation is a full-sized model of the fuel-containing core of the swimming pool research reactor which was operated at the conference in 1955. The original reactor has since been purchased by Switzerland for use in nuclear research. In conjunction with the full-sized operating model, a chart and color photographs will be used to demonstrate operation.

In addition to the Headquarters exhibit, a bronze plaque commemorating the 1955 conference has been installed by the European Office of the United Nations in the Galerie des Pas Perdus of the Palais des Nations, Geneva.

UNESCO Research Engineer to Calcutta. Students of electronics at Calcutta's Institute of Radio Physics and Electronics will have as instructor this year a research engineer from Sweden appointed by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) under the Expanded Technical Assistance Program of the UN and the specialized agencies.

Herbert Steyskal, who for the past eight years has been on the research staff of Sweden's Research Institute of National Defense at Stockholm specializing in the development of microwave tubes, will teach electronic science and aid in research development at the University of Calcutta in co-operation with Indian educational authorities.

At Calcutta he will give basic instruction on the building of electronic tubes and in the planning of experimental work to postgraduate students who are studying science and technology.

UNKRA Aids Gold Mines. Korean gold mines will be helped by the most recent loans granted by the United Nations Korean Reconstruction Agency (UNKRA) from a revolving fund set up to assist small mining enterprises.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Iron for Lightning Rods

To the Editor:

Benjamin Franklin, the great American philosopher and electrician born 250 years ago, was right when he advocated in 1752 the erection of lightning rods made of iron wire. The late Sir Oliver Lodge, the famous British scientist who was an expert on lightning protection proclaimed by numerous experiments that iron was the best material for lightning rods.

Many consultants on the subject, including this writer who has had 36 years practical experience, have proved beyond doubt in practice that a rod made of iron with its lower conductivity than copper the commonly used metal for this purpose will conduct to earth or in the reverse discharge, the most severe lightning stroke without any risk of sideflashing. The question of protecting lightning rods from corrosion when they are made of iron has for long presented a major difficulty.

In the past, terned and cast iron were resorted to in order to prevent oxidation,

with limited success. W. Hancock of Bristol patented an iron rope conductor after the manner of Franklin's thunder-rod, which he encased in molten lead, and the lead jacket gives the iron complete protection. This writer has seen the leaded-iron rope after exposure to an acid-biting atmosphere for 40 years and can certify it to be as sound as the day it was erected.

Let us revert to iron as the scientific and practical material used by Benjamin Franklin over two centuries ago. Lead encased iron has another advantage, it will not stain masonry as copper does when it becomes oxidized, a most important consideration.

Franklin's conductor was made of rod iron used by nailers, hence, the term lightning rod, and was most effective. His points and air terminal were brass and we must also stress that nonferric metal is the best for this purpose, bronze is always our choice.

C. J. Robb
Consultant

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ASTM STANDARDS ON MINERAL AGGREGATES AND CONCRETE. Published 1956 by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 346 pages, 6 by 9 inches, paper. $3.75. This complication includes the latest specifications and methods of test for crushed stone, crushed slag, gravel, and light weight aggregates; ready mixed concrete; air entraining admixtures; brick and block pavement materials; concrete curing material; expansion joint fillers; cement; and concrete reinforcing steel. A number of definitions of terms are also included.

ARCHITECTURAL GRAPHIC STANDARDS. By C. G. Ramsey and H. R. Sleeper. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., fifth edition, 1956. 758 pages, 9¼ by 11¾ inches, bound. $18.50. This reference volume for architects, builders, civil engineers, and others interested in building gives the standards and facts needed to deal with a wide range of types and phases of construction. The new edition has been thoroughly revised, and it has been rearranged into 23 sections covering such topics as foundations; wood, steel, concrete, and masonry construction; hardware; interior finishes; mechanical equipment; and landscaping. New material on a number of subjects has been added, including furniture, the design of plank and beam framing, curtain walls, pneumatic tubes, elevators, and escalators.

AUTOMATIC DIGITAL COMPUTERS. By M. V. Wilkes. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1956 305 pages, 5½ by 8¼ inches, bound. $7. Emphasizing general principles, this book covers design, principles of programming, relay computers, storage, switching circuits, and computing circuits. An introductory chapter surveys the development of computers from Babbage to EDVAC, and the last chapter deals with special problems of design and operation, the organization of a computer center, and applications in business and industrial processes. There is a detailed description of the EDSAC, and brief descriptions of EDVAC and other computers are included.

CHAMBERS D'EQUILIBRE. By André Gardel. 1956, F. Rouge et Cie, Lausanne, Switzerland. 1958 pages, 6⅜ by 9¼ inches, paper. Sw. Frs. 24.85. Part I of this mathematical treatment of hydroelectric plant surge tanks analyses the effect of various conditions such as the dimensions of the upstream reservoir, the angle of the surge tank riser, etc. In Part II, a method of rapid calculations is developed based on "relative values," expressing by a few parameters the co-ordinated variables of similar systems. The graphical as well as the analytical representation of the method is given.

THE CHEMISTRY OF THE COORDINATION COMPOUNDS. Edited by J. C. Gailar, Jr. and D. H. Busch. (ACS Monograph No. 131) Reinhold Publishing Corporation, 430 Park Ave., New York 22, N. Y., 1956. 834 pages 6 by 9¼ inches, bound. $18.50. This monograph is a comprehensive summary of fundamental topics, along with extended discussions of important applications, including applications in the electrode position of metals and in water softening. Contributions from 24 specialists cover such topics as theory, the structure of co-ordination compounds, chelation, large rings, olation, metal carbonyls and nitrosyls, and physical methods. Over 5,000 references are cited in bibliographical footnotes.

COMMUNICATION ENGINEERING. By W. L. Everitt and G. E. Anner. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y., third edition, 1956. 644 pages, 6 by 9¼ inches, bound. $9. The third edition of this standard work concentrates on the fundamentals of linear-network analysis including the use of unilateral elements. The opening chapters are devoted to general principles and methods of analysis, the later chapters to such topics as resonance, wave filters, reflection, lines of low loss, impedance transformation, impedance matching, equalization, linear amplifiers, and electromechanical coupling.

THE CONDENSED CHEMICAL DICTIONARY. Completely revised and enlarged by Arthur and Elizabeth Rose. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N. Y., fifth edition, 1956. 1,200 pages, 5⅞ by 9 inches, bound. $12.50. This dictionary lists, in one alphabet, chemical terms, raw materials, chemical substances, and trade name products, giving, where applicable, definitions, properties derivations, grades, containers used, shipping regulations, and uses. In the case of trade name products, reference is made to the manufacturer. A considerable number of new entries have been added to this edition.

THE DESIGN AND CONSTRUCTION OF ENGINEERING FOUNDATIONS. By F. D. C. Henry. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y., 1956. 547 pages, 5⅜ by 9⅛ inches, bound. $9. The aim of this reference book and text has been to link the design of foundations to the methods of structural analysis and soil mechanics, (subjects discussed in early chapters), to present examples of good current practice, and to summarize relevant research. The structures dealt with include individual and continuous footings, rafts, retaining walls, culverts, cofferdams, caissons, piles, bridge abutments, piers, and structures subject to the effect of mining subsidence. Problems in the planning, analysis, and detailing of foundations are provided in an appendix.

ELECTRONIC COMPONENTS SYMPOSIUM PROCEEDINGS. Seventh Session, Washington, D. C., May, 1956. Engineering Publishers, GPO Box 1151, New York 1, N. Y. 240 pages 8½ by 11 inches, paper. $5. These proceedings contain 43 papers grouped into the following sections: general, progress with materials, theory and operating principles, instruments and measurements, electron tubes and solid-state devices, and passive components. Typical subjects covered include ferrites for use in S-Band microwave components; glass in high temperature components; effects of nuclear radiation on components; automatic testing; high power silicon transistors; metal film resistors, and manufacturing subminiature tubes. Several of the papers deal with problems of equipment reliability.

ELEKTROMECHANISCHE SCHALTUNGEN UND SCHALTGERÄTE. By Otto Plechl. Springer-Verlag, Vienna, Austria, 1956. 224 pages, 6¼ by 9¼ inches, bound. $5.70. This manual is designed to provide a thorough grounding in the theory of electromechanical switchgear as well as an extensive treatment of the calculations necessary for effective design. The examples are presented in such a way that the practical man can compare his previous method of handling with that given in the book.

ELEVATED-TEMPERATRURE PROPERTIES OF COPPERS AND COPPER-BASE ALLOYS. (Special Technical Publication No. *181*). Compiled by a Joint Committee ASTM-ASME. The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1956. 244 pages, 8½ by 11 inches, paper. $5.50. A graphical summary of data on the mechanical properties of about 50 alloys and types of copper, mainly at temperatures of 300 to 900 F, but in a few cases, up to 1,500 F. The data includes modulus elasticity; tensile strength; yield strength; reduction of area; elongation; stresses for creep rates of 0.000001, 0.00001, and 0.0001 per cent per hour; and stress for rupture in 100, 1,000, 10,000, and 100,000 hours. The accompanying data sheets from which the graphs were prepared also give chemical composition, shape, size, and processing information on the specimens tested.

THE EMBRITTLEMENT OF METALS. By B. R. Queneau. Bibliography compiled by G. A. Ratz. The American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio, 1956. 90 pages 6 by 9¼ inches, bound. $3. The first of these lectures is a general treatment of the subject, covering embrittlement resulting from a phase change and embrittlement by gases. The other three lectures deal with temper brittleness in low and medium carbon alloy steels, tempered martensite brittleness in hardened steels, and embrittlement in stainless steels. The accompanying bibliography consists of 215 selected references.

ENGINEERING ANALYSIS. By S. H. Crandall. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y., 1956. 417 pages, 6 by 9¼ inches, bound. $9.50. This monograph is concerned with the analysis and numerical solution of complex engineering problems. The first three chapters deal with equilibrium, eigenvalue, and propagation problems in systems with a finite number of degrees of freedom; the last three chapters, with similar types of problems in continuous systems. In each chapter, representative problems from such fields as elasticity, heat transfer, fluid mechanics, and electric circuits are presented. Mathematical models for these are then formulated, and the classical mathematical theory reviewed before proceeding to the discussion of numerical procedures. Procedures suitable for hand and machine computation are given, including iteration, relaxation, perturbation, and finite difference methods.

ENGINEERING FLUID MECHANICS. By Charles Jaeger. Translated from the German by P. O. Wolf. Blackie and Son, Glasgow, Scotland, 1956. 529 pages, 6¼ by 9⅜ inches, bound. 60s. The chief aim of this book is to present the methods of analysis and calculation required in using water for power. The four major sections of the book deal with fundamental hydrauiic principles, steady flow, unsteady flow, and flow in underground strata. Particular attention is paid to basic hydrodynamic equations, open-channel flow, surge tanks, and water hammer. Numerous bibliographical footnotes are included. The book is a revised and enlarged version of the author's "Technische Hydraulik," published in German in 1949 and in French in 1954.

EXPLORATION FOR NUCLEAR RAW MATERIALS. Edited by R. D. Nininger. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1956. 293 pages, 6 by 9¼ inches, bound. $7.50. Thirty-three papers from the International Conference on the Peaceful Uses of Atomic Energy are the basis of this volume, which is one of a series of presentations of significant material on selected subjects treated at the Conference. The contents of the papers have been edited and rearranged to provide a cohesive account of two major topics: the geology of uranium and thorium and prospecting techniques. Most of the chapters include lists of references.

HANDBOOK OF CHEMISTRY. Edited by N. A. Lange. Handbook Publishers, Inc., Sandusky, Ohio, ninth edition, 1956. 1969 pages, 5⅛ by 8 inches, bound. $8.50. In preparing the present edition of this standard handbook for chemists and engineers, the editor has rearranged and rewritten the material of the previous edition in order to make room for new subjects and still keep the volume of convenient size for quick reference. The additions cover such varied topics as composition and properties of nonferrous alloys, sodium and potassium alloys, the plain carbon and low alloy steels; efficiency of drying agents; physical properties of the earth and its atmosphere; and luminescence. Formula weights of inorganic compounds, and gravimetric and volumetric factors have been recomputed to conform to the values in the 1955 International Atomic Weight Table.

A HANDBOOK ON BELT CONVEYOR DESIGN. Compiled in association with Hewitt-Robins, Inc., New York, N. Y., and published by the General Electric Company, Ltd., Erith, Kent, England, 1956. 148 pages, 5¾ by 9¼ inches, bound. 30s. Detailed explanations and calculations for the design of individual conveyors are given in this handbook. The first section of the book deals with the factors to be taken into account in the design of conveyors for specific purposes, and the following sections take up such essentials as idlers, drive equipment, trippers, brakes, and shaft design. Sample calculations for several types of conveyors are included, and tables of data are provided.

HEAT POWER FUNDAMENTALS. By C. M. Leonard and V. L. Maleev. Pitman Publishing Corporation, 2 West 45th St., New York 19, N. Y., second edition 1956. 527 pages, 6 by 9¼ inches, bound. $7. In addition to presenting the fundamentals of

thermodynamics, this text deals with steam, internal combustion, and gas turbine power plants, and includes a chapter on mechanical refrigeration. A new feature of the present edition is the treatment of the problems of heat transfer in a separate chapter. Tables of properties of steam and air are appended.

HIGH PRESSURE TECHNOLOGY. By E. W. Comings. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y., 1956. 572 pages, 6 by 9¼ inches, bound. $11.50. A comprehensive review, for engineers in industry, of the influence of high pressure on chemical and physical systems, as well as on the design of equipment for handling these systems. Relevant processes are listed, and the selection of metals for equipment dealt with, as background for the discussion of design principles, safety, unit operations, chemical equilibrium, chemical reactors, experimental techniques, and the behavior of gases and liquids. The analysis of stresses and strains in thick-walled cylinders is also treated, and the synthesis of ammonia is dealt with as an example of the engineering of a high-pressure process.

HÜTTE. Volume 3: Bautechnik. Wilhelm Ernst und Sohn, Berlin, Germany, 28th edition, 1956. 161 pages, 4¾ by 7¼ inches, bound. DM 42. The main topics dealt with in the present volume of this standard German handbook for engineers are statics; wood, steel, and concrete construction; water supply and sewage; heating and ventilating; construction machinery; city planning; dams; tunnels; foundations; bridges; and highways. In this edition, some textual revisions have been made, some new material is supplied in a supplementary section, and a new section covering prestressed concrete and compound construction has been added.

THE INTERNATIONAL DICTIONARY OF PHYSICS AND ELECTRONICS. Published by D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1956. 1,004 pages, 7¼ by 10¼ inches, bound. $20. In the preparation of this dictionary, the needs of engineers, specialists in other fields, and users lacking an extensive mathematical background have been kept in mind as well as the needs of professional physicists. Both formal and discursive definitions are given, and a number of terms from subject-areas bordering on physics are included, e.g., physical chemistry, applied electronics, applied electricity, and mathematics. In addition, units and systems of units are explained in an extended introduction. The main fields covered are mechanics, heat, and thermodynamics; low temperature physics; properties of gases, liquids, and solids; acoustics; optics; nuclear physics; and mathematical physics.

MAINS PRACTICE. By T. H. Carr. George Newnes, Ltd., London, England, 1956. 352 pages, 5½ by 8¾ inches, bound. 35s. This is a broad treatment of the design, construction, operation, and maintenance of transmission and distribution systems, intended both for practicing engineers and engineering students. It deals with both underground and overhead lines, and there is full discussion of cables and methods of cabling. The emphasis is on British regulations, standards, and practices.

MANGANESE STEEL. Published for Hadfields Limited-Sheffield by Oliver and Boyd, Edinburgh 1, Scotland. 128 pages, 5⅛ by 9 inches, bound. 18s. A summary of present knowledge, covering historical background, manufacture and processing, metallography, properties, heat treatment, work-hardening, machining, welding, influence of temperature on properties, and modifications in composition. Nonmagnetic steel for electrical purposes is briefly described, and industrial applications are noted.

MATHEMATICS FOR ELECTRONICS. By H. M. Nodelman and F. W. Smith. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y., 1956. 391 pages, 5⅞ by 9¼ inches, bound. $7. The mathematics treated include dimensional analysis, the algebra of determinants, matrix algebra, series approximations, classical and La Place transform methods for solving differential equations, and Boolean algebra. Over 300 specific practical applications, selected from the technical literature are incorporated into the text, and numerous worked out examples, as well as exercise problems, are included.

MECHANICS OF THE ROLLER CHAIN DRIVE. By R. C. Binder with the collaboration of the engineering staff of the Diamond Chain Company. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1956. 204 pages, 5½ by 8½ inches, bound. $5. This mathematical analysis of the dynamics and statics of roller chains operating over sprockets provides a basis for developing the power capacity, or rating, of roller chain drives. Among the factors analyzed are centrifugal force, tooth pressure angle, roller velocity, sprocket velocity, chain strand vibration, and the path of the chain strand. The last chapter is an analytical study of a single type of roller chain drive, made in order to outline a general method for rating drive.

MEMOIRS OF THE UNIFYING STUDY OF THE BASIC PROBLEMS IN ENGINEERING SCIENCES BY MEANS OF GEOMETRY. Volume I. Published 1955 for the Unifying Study Group by Gakujutsu Bunken Fukyu-Kai, Tokyo, Japan. 590 pages, 7⅝ by 10⅜ inches, bound. (Approximately) $12.50. The papers produced by this research group are intended to demonstrate the application of tensor theory and geometrical-topological concepts to practical engineering problems. Stemming from Kron's work on electrodynamics this project has been expanded to cover, in this volume, not only electromagnetism and electric networks, but also elastic deformation, stress fields, crystal structure, plasticity and yield points, aerodynamics, the dynamics of granular media, dynamical systems in general, and tension-field theory. Subsequent volumes will further extend the scope of the work, which it is hoped will provide topics for future investigation rather than be considered as essential solutions along any line.

ORDINARY NON-LINEAR DIFFERENTIAL EQUATIONS IN ENGINEERING AND PHYSICAL SCIENCES. By N. W. McLachlan. Oxford University Press, 114 Fifth Ave., New York 11, N. Y., second edition, 1956. 271 pages, 6 by 9½ inches, bond. $5.60. Confined chiefly to the presentation of various analytical methods for the solution of engineering problems, this text covers equations readily integrable, equations having periodic solutions, the equivalent linear equation, equations having periodic coefficients, the method of slowly varying amplitude and phases, and graphical and numerical solutions. Among the new topics treated in this edition are phase trajectories, stability criteria, and fluid flow in two dimensions. References are given to more rigorous theoretical treatments of the methods discussed.

THE POTENTIALS ABOUT A POINT ELECTRODE AND APPARENT RESISTIVITY CURVES FOR A TWO-, THREE-, AND FOUR-LAYERED EARTH. By H. M. Mooney and W. W. Wetzel. The University of Minnesota Press, Minneapolis 14, Minn., 1956. 146 pages, 6½ by 9¼ inches, bound. $4.50. Set of curves, $15. Complete, $18. The purpose of this book is to present expected or theoretical curves for a variety of layered geologic structures, to be used in calculating the depth and nature of subsurface materials by the electrical resistivity method. It includes tables of potential functions for computing apparent resistivity curves for any electrode arrangement several auxiliary tables, a set of master resistivity curves, an explanation of the mathematical basis for the table and curves and instructions for their use. The resistivity curves are published on loose sheets of graph paper.

POWER PLANTS. By A. H. Zerban and E. P. Nye. International Textbook Company, Scranton 9, Pa., second edition, 1956. 655 pages, 6 by 9¼ inches, bound. $8.50. The new edition of this text, previously published under the title "Steam Power Plants," has been broadened in scope to provide a co-ordinated treatment of all types of power-generation equipment. The material on internal combustion plants has been expanded, a new chapter on hydro plants has been added, and recent developments such as supercritical vapor cycles and nuclear power are discussed.

POWER SYSTEM STABILITY. Volume 3. Synchronous Machines. By E. W. Kimbark. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1956. 322 pages, 5⅞ by 9¼ inches, bound. $10. The final volume of a work intended for power-system engineers and graduate students. Devoted to the theory of synchronous machines and their excitation systems, the book deals with such major topics as reactances, resistances, time constants, short circuits, saturation, damping, and damper windings. Steady-state stability, briefly treated in the first volume, is discussed fully in the present volume.

PRACTICAL PETROLEUM ENGINEERS' HANDBOOK. By Joseph Zaba and W. T. Doherty. Gulf Publishing Company, Box 2608, Houston, Tex., fourth edition, 1956. 818 pages, 5⅜ by 8⅛ inches, bound. $14. An extensive compilation of tables, charts, and formulas connected with drilling and production practice, including sufficient explanatory text material for practical use. There are also separate chapters on general engineering data. About 150 pages of new material have been added in this edition.

PULSE AND DIGITAL CIRCUITS. By Jacob Millman and Herbert Taub. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y., 1956. 687 pages, 6 by 9¼ inches, bound. $12. The principal emphasis in this text for senior and graduate electrical engineering students is on the theory of circuits and techniques. The book takes up, in sequence, the response of active and passive linear networks to the various wave forms; nonlinearities of tubes and semiconductor devices; the effect of nonlinearities on wave form transmission; wave form generating and other basic circuits; pulse and digital systems (specifically, television and radar); and transitors. Insofar as possible, approach is physical rather than mathematical.

ROCKET PROPULSION ELEMENTS. By G. P. Sutton. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., second edition, 1956. 483 pages, 5½ by 8⅛ inches, bound. $10.25. Designed as a reference manual and college text, this book deals with both liquid and solid propellant rockets, their fuels, physical mechanisms, and design. It also includes material applicable to both types: general principles of thermodynamics, heat transfer, flight theory, testing methods, and historical background. There is a bibliography of over 600 references.

SYMPOSIUM ON IMPACT TESTING. (ASTM Special Technical Publication No. 176) American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1956. 169 pages, 6 by 9 inches, paper. $3.50. In addition to a number of papers on notched bar testing, this symposium includes papers on shock tests that deal with tests for parts, components, and complete structures. Typical subjects dealt with are testing from room temperature to −236 C; longitudinal impact tests of long bars with a slingshot machine; a shock tester for shipping containers; and properties of concrete at high rates of loading. The impact tube is discussed in one of the papers.

THE THEORY OF PRESTRESSED CONCRETE DESIGN. By H. J. Cowan. St. Martin's Press, 103 Park Ave., New York 17, N. Y., 1956. 264 pages, 5½ by 8¾ inches, bound. $8.25. A comprehensive theoretical treatment, based on British, American, and Australian practice. As well as dealing in detail with the design of the cross-section of pretensioned and post-tensioned beams, the book contains a chapter on the design of tanks and pipes. Other subjects covered include the design of the steel profile in eccentrically stressed beams, shear and torsions, bond and anchorage, deflection, and ultimate strength in bending.

THERMOCHEMICAL DATA OF ALLOYS. By O. Kubaschewski and J. A. Catterall. Pergamon Press, 122 E. 55th St., New York 22, N. Y., 1956. 200 pages, 5½ by 8¾ inches, bound. $7.50. A compilation of data on intermetallic systems and on oxides, sulphides, nitrides, phosphides, and carbides. All the relevant data necessary to establish free energy diagrams is presented, and partial and integral heats, entropies, and free energies are assessed. A list of the 537 sources cited in the text is given at the end of the book.

THE ULTIMATE-LOAD THEORY APPLIED TO THE DESIGN OF REINFORCED AND PRESTRESSED CONCRETE FRAMES. By A. L. L. Baker. Concrete Publications, Ltd., London, England, 1956. 91 pages, 5⅞ by 9¼ inches, bound. $4. This is an exposition of a design method based on the assumption of plastic hinges in frames, developed at the Imperial College of Science and Technology in London, England. The following topics are treated: ultimate strength in bending of beams, plastic deformations of hinges and the ultimate strength of frames, general expressions for rotations of plastic hinges, and general analysis of four-bay frames. Examples of applications of the plastic hinge theory in the design of continuous beams and building frames are given in the last chapter.

THE UPPER ATMOSPHERE. By S. K. Mitra. The Asiatic Society, Calcutta, India, second edition, 1952. 713 pages, 6½ by 10 inches, bound. 48 Rupees. This comprehensive account of the present state of knowledge of the upper atmosphere covers a wide range of subjects of interest to engineers in the fields of rockets, radio, and aeronautics, as well as to meteorologists and other specialists. Concerned with regions more than 30 miles above the surface of the earth, the book deals with composition, temperature, density, tides, electrical currents, magnetic storms, lights from the night sky, meteoric phenomena, and auroras. One section is devoted to applications of ionospheric data to radio transmission, and the last chapter discusses rocket atmosphere. There is a bibliography.

VACUUM-TUBE CIRCUITS AND TRANSISTORS. By L. B. Arguimbau, with transistor contributions by R. B. Adler. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1956. 646 pages, 5⅞ by 9¼ in., bound. $10.25. Stressing fundamental principles, this book covers components and their associated

circuits, amplitude and frequency modulation, power amplifiers, oscillators, transient response, inverse feedback, transit time, and noise. As the title implies, the book is concerned primarily with circuitry rather than the physics of the devices used in circuits. However, in the two chapters devoted to transistors, considerable attention is paid to the devices themselves and to the physics behind them. Also, enough descriptive material on other devices is given to make previous knowledge of vacuum electronics nonessential.

WARMFESTE UND KORROSIONSBESTÄNDIGE SINTERWERKSTOFFE. (Proceedings of the Second Planee Seminar, 1955) Edited by F. Benesovsky. Springer-Verlag, Wien, Austria, 1956. 472 pages, 6 by 9¼ inches, bound. $10.30. An edition with English summaries of the foreign language papers is available from Pergamon Press, Inc., New York, N. Y. $12.50. The 38 papers presented at this seminar deal with a wide range of topics concerning carbides and other very hard materials: physico-chemical and metallurgical aspects; characteristics and properties of various metallic and ceramic materials; specific applications of hard materials, including the role of powder metallurgy in the design of nuclear power reactors; and miscellaneous papers on sintering problems and other aspects of powder metallurgy. Papers are in German or English.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

ENGINEERING FORMULAS AND TABLES. Civil, mechanical, and electrical engineers will find this newly revised data book an indispensable tool. It contains 350 pages of basic formulas, design data, and tables for the three branches of engineering. Condensed, indexed, and mathematically accurate, 12 division sheets with printed tabs furnish immediate access to the particular information desired. Sections include mathematics, measures, materials, gauges, screws, mechanics, electricity and magnetism, hydraulics, structural data, reinforced concrete, pipe and fittings, steam tables, and mathematical tables. This new data book is the result of 40 years of compilation, condensation, and revision. Handy, pocket size, it sells for $2.75. For catalogue giving 2,000 listings write Lefax Publishers, Philadelphia 7, Pa.

TRANSISTOR CIRCUIT HANDBOOK. By L. E. Garner, Jr. With the emergence of the transistor from the laboratory experimental state to its present status in the component field in radio as well as television and other phases of electronics, it becomes increasingly necessary for the forward looking technician to acquaint himself with transistor circuits. This book serves that purpose. It is a practical reference book covering over 200 basic circuits, practical applications and reference data on the uses of transistors. The book is written in four parts. Part one is devoted to Laboratory Practice as far as transistors are concerned. Part two covers Basic Circuits. These are circuits for experimental study or which may be used as "building blocks" in various combinations in the design of equipment. Part three covers Circuit Applications. In some cases, practical construction hints are given. In all cases, values will be shown and component types specified. Part four covers general reference material of value in circuit work. Published by Coyne Electrical School, Technical Book Publishing Division and distributed by Howard W. Sams and Company, Inc., Indianpolis, Ind., the handbook contains 430 pages and is available through electronics parts suppliers at $4.95.

ELECTRONIC SCHEDULING MACHINE REQUIREMENTS. How today's electronic computer technology can be used to aid production management in the determination of shop schedules, both for data-processing and decision-making, is discussed in this report of research for the U. S. Navy available for industry use through the Office of Technical Services (OTS), U. S. Department of Commerce. Computer equipment already exists which can perform the scheduling functions for plants of medium size, the report states, and extension of the operation to many more plants awaits only modification to more efficient and economic design. The report describes investigations into the feasibility of applying electronic computer technology to shop scheduling, ways of applying it, and requirements in equipment and methods. Illustrative times and costs based on one plant studied are presented, and desirable computer characteristics are considered. This report, *PB* 121117, R. B. Canning, University of California for the Office of Naval Research, March 1955, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C. It contains 43 pages, price $1.25.

COMMON SENSE IN SCHOOL LIGHTING. Released by the American Association of School Administrators, a department of the National Education Association, this 24-page pamphlet was prepared by a recognized authority on school lighting. It offers practical and economical solutions and presents briefly and in nontechnical language the most up-to-date and sound information that scientific research has to offer. School superintendents, their architectects, and their staff members will find this pamphlet a handy and valuable guide. 50¢, discount on quantity orders. Order from American Association of School Administrators, 1201 16th St., N. W., Washington 6, D. C.

SCATTER PROPAGATION THEORY AND PRACTICE. By Ira Kamen and George Doundoulakis. This book covers ionospheric and tropospheric propagation in both theory and practice. Throughout the text there is distributed considerable original information developed by the authors in their work as well as actual photographs of equipment and installations of scatter propagation systems. The authors also present some of the original thinking of outstanding experts of the Collins Radio Company, General Electric Company, National Bureau of Standards, Marconi, and others who are pioneering in the new field. The book delineates such new test techniques as miniaturized design, waveguide inspection, and polar measurements. Also contained is descriptive material showing the activity of technicians and installers on the DEW Line, installing and testing parabolas and antenna feeds. Mathematics has been reduced to descriptive copy where possible. Where mathematics must be shown, it is outlined with an example showing the application of the mathematics so that the technician can use the text as a reference in solving practical problems. The authors have written this book for service technicians as well as engineers so that the Scatter Propagation information can be disseminated to the widest market. The book contains 204 pages and is priced at $3. Published by Howard W. Sams and Company, Inc., 2201 E. 46th St., Indianapolis 5, Ind.

THE RADIO-ELECTRONIC MASTER. Containing 1,546 pages, the 1957 edition is the largest catalogue ever published for the electronic industry. Over 125,000 items of 350 manufacturers are included. This industry-wide reference volume meets the critical requirements of those who buy, sell, specify, design, manufacture, and service electronic parts and equipment. Detailed descriptions, specifications, and prices are given. More than 11,250 illustrations are shown. The buying guide's detailed set of indexes pinpoint the many thousands of products which include: tubes, test equipment, capacitors, resistors, relays, coils, antennas and accessories, transformers, recording and PA systems, Hi-Fi equipment, hardware, tools, transmitters, communication receivers, wire and cable, speakers, microphones, rectifiers, converters, amateur gear, switches, volume controls, etc. The 21st edition of this catalogue may be obtained from electronic parts distributors. Names will be furnished on request by United Catalog Publishers, Inc., 110 Lafayette St., New York 13, N. Y.

SAFE PRACTICE FOR HOSPITAL OPERATING ROOMS. A revised advisory pamphlet, *NFPA No. 56*, published by the National Fire Protection Association. This edition supersedes a 1954 edition and includes a number of changes to bring it up to date. One of the most significant of these is the requirement of uniform electrical receptacle and attachment plugs designed to eliminate the previous confusion involved in noninterchangeable electrical equipment and the danger that do-it-yourself electricians, confronted with the necessity of altering equipment to fit different electrical systems, would create a fire hazard. There is also new material on differentiation between different types of rayon and other synthetic fabrics which must be strictly regulated in hospital operating rooms in order to eliminate the danger of static electricity. This pamphlet, while purely advisory as far as the NFPA is concerned, has wide influence in governing the construction and operation of hospital operating rooms. It was developed by the NFPA Committee on Hospital Operating Rooms under the chairmanship of Roy Hudenburg of the Miners Memorial Hospital, Williamson, W. Va., and has been endorsed by the American American College of Surgeons, The American Hospital Association, and the U. S. Veterans Administration. Single copies of this pamphlet, *NFPA No. 56*, 48 pages, are available from the National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., at 25¢ per copy.

IMC ELECTRICAL INSULATION MANUAL. An authoritative and useful guidebook to electrical insulating materials published by the Insulation Manufacturers Corporation. The 300-plus page book is the first to describe and evaluate all of the commonly used insulations for electrical and electronic equipment in a single volume. The manual is sectionalized and tab-indexed for convenience in locating the 16 different chapters, each devoted to different types of electrical insulating materials. Original illustrations, drawings, specification tables, and graphs help the user to determine how well a specific product will solve his electrical insulation need. A complete alphabetical index and a guide to official standards for electrical insulating materials are also provided. The manual is available on request to users and specifiers of electrical insulating materials; price $5. Copies may be obtained by writing to the Publications Department, Insulation Manufacturers Corporation, 565 West Washington Blvd., Chicago 6, Ill.

STANDARD X-RAY DIFFRACTION POWDER PATTERNS. National Bureau of Standards Circular 539, Volume 6, by H. E. Swanson, N. T. Gilfrich, and M. I. Cook, issued September 26, 1956. This circular presents 44 standard X-ray diffraction powder patterns, 23 of which replace 33 patterns already represented 23 of which replace 33 patterns already represented in the X-ray Powder Data File. It is the sixth of a series and contains substances not previously represented. These patterns are used in many applications, the most important being the identification of unknown crystalline materials. In this circular, comparison is made of all powder diffraction data available for each of the substances reported. The patterns were made with a Geiger counter x-ray diffractometer, using high purity samples. The d-values were assigned Miller indices determined by comparison with calculated interplanar spacings and from space group considerations. The densities and lattice constants were calculated, and the refractive indices were measured whenever possible. 62 pages, 40¢. Order from the Government Printing Office, Washington 25, D. C. Foreign remittance must be in U. S. exchange and should include an additional one-third of the publication price to cover mailing costs.

ACCIDENT FACTS. The 1956 edition of the National Safety Council's statistical yearbook, contains facts and figures on all types of accidents—industrial, traffic, home, farm, and school. The book has 20 pages devoted exclusively to occupational accidents and provides the factual background necessary to give direction to an industrial safety program. There is a detailed list of accident rates by major industry groups, as well as charts showing accident trends during the past 30 years. Most common source of injuries, part of body most frequently injured, off-the-job accident problems, unsafe acts and unsafe conditions contributing to permanent impairments and deaths, and other topics are included. The 96-page book is an invaluable source of ideas and data for making speeches, writing articles, preparing reports, and planning safety campaigns. The book is priced at $1 a single copy and less for quantities. Inquiries should be sent to the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

SYMPOSIUM ON THE APPLICATION OF TRANSISTORS IN MILITARY ELECTRONICS EQUIPMENT. A collection of technical papers presented at a Symposium on the Application of transistors in Military Electronics Equipment sponsored by the Department of Defense in 1953 is available for industry use from the Office of Technical Services (OTS), U. S. Department of Commerce. The 32 papers contained in the 508-page, illustrated volume are concerned with fabrication of transistors by laboratory or pilot line techniques or combinations of both. The symposium was held at Yale University and featured speakers from both military and industrial laboratories. The publication, *PB 111680*, Committee on Electronics, Office of the Secretary of Defense, Nov. 1953, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C., price $5.

ORGANIZATION OF ELECTRIC POWER SERVICES IN EUROPE. United Nations Economic Commission for Europe; Geneva, 1956; now available in French and English editions and shortly will be available in Russian. The manual gives information on the manner in which the electric power services are organized in 19 Eastern and Western European countries, covering the organization of government services, of private or national interests, and of associations of such undertakings. Information is also furnished on certain bodies connected with research and publicity. Another part of the manual reports of intergovernmental and nongovernmental organizations concerned with European electric power. The 126 pages include 10 tables. Price 40¢, 3 shillings, Sw. frs. 1.50, or the equivalent in local currencies. May be obtained from the Sales Section, European Office of the United Nations, Geneva, Switzerland, or may be ordered through Sales Agents for United Nations Publications.

are you killing that still, small voice?

When that voice prods your professional ego with, "You can do bigger and better things!," do you smother it with a wet blanket of doubt?

And when that same voice whispers to you of a gentle climate where the snow is yours just for the asking and sunshine is always yours for the basking, do you clobber it with the sledge hammer of self-denial?

Don't kill that voice! Its wisdom could lead you to a place where you'll find those bigger things, that better life—Firestone. If you've a mind that can matter in the guided missile field, Firestone needs you in its vital development program for the Army's "Corporal," first surface-to-surface guided ballistic missile. Here are just a few of our needs:

Flight Simulation
Electronics Systems
Missile Component Design
Systems Analysis
Structural Design
Field Engineering

Next time you hear that still, small voice, don't reach for your shotgun. Reach for your pen. Write—right now! Let that still, small voice guide you to big accomplishment for you, big happiness for your family!

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GUIDED MISSILE DIVISION

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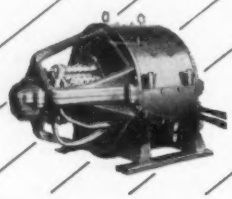
INDUSTRIAL

Motor and Generator Brushes



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The Ohio Carbon Company has produced performance proven brushes for over 40 years which are applied in all applications on rotating electrical equipment. Our completely equipped laboratory develops brushes in a grade of material that will give long trouble-free life for specific uses.

In the field of replacement brushes for industrial equipment we have been for many years the leaders in providing brush materials adapted to actual operating needs. Our brush replacement service is beyond reproach.

Send for our catalog No. 18-A and you will find that it is NOT a listing of standard brushes but a complete guide to understanding industrial brush construction, commutator and brush maintenance. A letterhead request will bring a copy of this catalog by return mail.

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Over 40 Years of Experience in this field!

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INDUSTRIAL NOTES ....

RCA Sound System in Coliseum. The New York Coliseum, the nation's largest exhibition building for trade shows and fairs, is using a four-in-one Radio Corporation of America (RCA) industrial sound system to provide exhibitors with service in all sections of the huge structure. The installation incorporates four separate sound systems, one for each of the building's four exhibition floors. They can be used individually or interconnected for building-wide operation. The system was planned and installed by Commercial Radio-Sound Corporation, New York distributor for RCA Sound Products and Industrial Sound systems. Each floor has its own self-contained control room. The floors are divided into four separate sound zones, and programs originating from any zone on any floor can be confined to that zone, distributed to all zones on the same floor, or transmitted to any or all zones on other floors of the Coliseum. Sixteen microphone circuits and facilities for amplifying four different program sources are provided on each floor. In addition to microphone originations, the program sources include a-m/f-m radio, turntable for phonograph records, and a wire line input for remote program pickup. A special sound-reinforcing installation is provided for the Coliseum's main exhibit floor. This incorporates two powerful RCA theater-type speaker systems mounted above the stage area, twelve 12-inch high fidelity loudspeakers mounted along the walls, and six 60-degree radial-type horns spaced among the high fidelity loudspeakers to provide added coverage and controlled horizontal wide-angle sound dispersion.

Computer for Oil Industry. An ALWAC electronic computer, manufactured by Logistics Research Inc., of Redondo Beach, Calif., was installed at the Southwestern Computing Center, Tulsa, Okla., to solve complex oil and gas industry problems. This is the second ALWAC that will be used by the Petroleum industry. Another was sold to Champlin Refining Company, of Fort Worth, Tex. Champlin will use their ALWAC to compute the precise balance in blending crude oil. The oil and gas industry is beginning to make use of the electronic computer in solving problems so complex that they were practically impossible of solution by conventional precomputer methods. Reported applications now include oil explorations and other research calculations, simulating refining operations, production of oil, blending, data reduction, evaluation of elaborate integrals, solution of differential equations, matrix calculations, tanker and pipeline scheduling, truck routing, market analysis, profit per product information, and payroll and accounting.

Managers Named. Square D Company has named Walter Nollenberger as manager of a major new manufacturing plant to be built in Lexington, Ky., and Stephen Kovach as manager of a smaller regional assembly plant now under construction in Atlanta, Ga. Both plants are scheduled for completion in 1957. Mr. Nollenberger has been chief manufacturing engineer of Square D's Distribution Equipment Division, with headquarters in the Detroit, Mich., plant. He joined the company in 1945 as a tool and die designer and has successively held various production and administrative positions. Mr. Kovach has been supervisor of the industrial engineering section in Square D's Royal Oak, Mich., plant. He joined the company in 1947 as a senior clerk in the production engineering department and subsequently held various manufacturing and engineering posts, including a period in the company's Cedar Rapids, Iowa, plant.

West Coast Plant. Erie Resistor Corporation, Erie, Pa., has announced the construction of a new plant on the West Coast for its rapidly expanding Electromechanical Division. The plant will be located at 13010 S. Weber Way, Hawthorne, Calif., and will supply the entire West with Erie assemblies. George Osborn, district manager of sales in Los Angeles, Calif., has been named manager of the Erie-Pacific Works. In addition to his new duties, he will also be in charge of all sales activities for the Electromechanical Division on the West Coast. Joseph Martin, plant manager of Elgin Laboratories, Waterford, Pa., for the past year, will be superintendent in charge of manufacturing at the new California factory. Mr. Martin has been with Erie for over 20 years in various manufacturing capacities.

Light that "Breathes." A revolutionary commercial lighting fixture that "breathes" cooled air, is expected to chop drastically mass air-conditioning installation costs. Called the Multi-Vent Troffer, this single dual-purpose ceiling fixture provides both air distribution and lighting, performing a job that formerly required two separate units. It is adaptable to any drop-type ceiling. Two firms, Pyle-National Company, air distribution manufacturer of Chicago, Ill., and Benjamin Electric Company, lighting equipment manufacturer of Des Plaines, Ill., jointly engineered and designed the new unit, first of its kind to be produced. It is designed for offices, stores, factories, laboratories, restaurants, hotels, hospitals, and schools. The Multi-Vent Troffer looks like a regular recessed fluorescent light fixture. A completely concealed built-in air diffuser, mounted above the reflector plate, distributes air which bypasses the lamps. A booklet about the Multi-Vent Troffer is available from the Pyle-National Company, Chicago 51, Ill., or Benjamin Electric Manufacturing Company, Des Plaines, Ill. It contains cutaways, exploded views, sound level charts, and all data pertinent to the selection or correct fixture parts.

(*Continued on page 16A*)

Kepco

VOLTAGE REGULATED POWER SUPPLIES

for Transistors • Strain Gages
Relays • Filament Power

MODEL	Volts	Current	Regulation Line 105-125	Regulation Load 0-Max.	Ripple	Recovery Time*	Stability For 8 Hours	Output Impedance DC-20 ~	Output Impedance 20 ~ —100 KC	Dimensions W	Dimensions H	Dimensions D	Price
2600	0-60	0-2 Amp.	5 Mv.	5 Mv.	1 Mv.	50 μ sec.	10 Mv.	0.002 Ω	0.0005Ω	19″	10½″	17″	$690
2650	0-60	0-5 Amp.	5 Mv.	5 Mv.	1 Mv.	50 μ sec.	10 Mv.	0.001 Ω	0.0002Ω	22½″	28″	19″	$1190

Good stability
Fast recovery time
Low output impedance
Excellent regulation
Low ripple

POWER REQUIREMENTS: 105-125 volts, 60 cycles.
FUSE PROTECTION: Input and output fuses on front panel. Time delay relay is included to prevent unregulated voltage from appearing at the output terminations.
OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. Either positive or negative terminal of the supply may be grounded. DC terminals are isolated from the chassis. A binding post is available for connecting to the chassis. All terminals are also brought out at the rear of the unit. Two terminals are mounted at the rear of the chassis to provide for picking up the error signal directly at the load. This connection compensates for the voltage drop in the wires (and ammeter) connecting the power supply to the load.
METERS: Ammeter: 0-2 amperes, 4″ rectangular for Model 2600
0-5 amperes, 4″ rectangular for Model 2650
Voltmeter: 0-60 volts. 4″ rectangular
CONTROLS: Power on-off switch, DC on-off switch, remote error signal on-off switch, coarse and fine voltage controls. The coarse voltage control is a ten turn potentiometer which varies the voltage from 0-60 volts. The fine voltage control is a ten turn potentiometer which varies the voltage 1 volt. The voltage divider network allows a 61 volt variation in output voltage.
*Recovery time is less than 50 microseconds. The excursion in the output voltage during the recovery period is less than 50 millivolts for line fluctuations from 105-125 volts or load variations from 0-to maximum current.

FOR COMPLETE LINE
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Standard types of COMMUNICATION EQUIPMENT

Radio Engineering Products is currently producing a number of types of equipment, electrically and mechanically interchangeable with standard Bell System apparatus. Complete equipments of the following types, and components for these equipments are available for early delivery.

CARRIER-TELEPHONE EQUIPMENT

C5 Carrier-Telephone Terminal (J68756). A kit for adding a fourth standard toll-grade channel to existing C systems is available.
C1 Carrier-Telephone Repeater (J68757)
121 A C Carrier Line Filter and Balancing Panel
H Carrier Line Filter and Balancing Panel (X66217C)

CARRIER-TELEGRAPH EQUIPMENT

40C1 Carrier-Telegraph Channel Terminal (J70047C)
140A1 Carrier Supply (J70036A1, etc.)
40AC1 Carrier-Telegraph Terminal
Grid Emission Test Set (J70047D1)

VOICE-FREQUENCY EQUIPMENT

V1 Telephone Repeater (J68368F)
Power Supply (J68638A1)
V1 Amplifiers (J68635E2 and J68635A2)
V3 Amplifier (J68649A)
V-F Ringers (J68602, etc.)
Four Wire Terminating Set (J68625G1)
1C Volume Limiter (J68736C)

D-C TELEGRAPH EQUIPMENT

16B1 Telegraph Repeater (J70037B)
10E1 Telegraph Repeater (J70021A)
128B2 Teletypewriter Subscriber Set (J70027A)
Composite Sets, several types

TEST EQUIPMENT

2A Toll Test Unit (X63699A)
12B, 13A, 30A (J64030A), and 32A (J64032A) Transmission Measuring Sets
111A2 Relay Test Panel (J66118E)
118C2 Telegraph Transmission Measuring Set (J70069K)
163A2 Test Unit (J70045B)
163C1 Test Unit (J70045D)

COMPONENTS AND ACCESSORIES

255A and 209FG Polar Relays
Repeating Coils, several types
Retard Coils, several types
184, 185, 230A and 230B Jack Mountings

VACUUM TUBES

101D, F and L	323A and B	396A
102D, F and L	328A	398A
104D	329A	399B
205D	336A	400A
274A and B	350 A and B	408A
281A	355A	120A Ballast Lamp
305A	393A	121A Ballast Lamp
310A and B	394A	

RADIO ENGINEERING PRODUCTS
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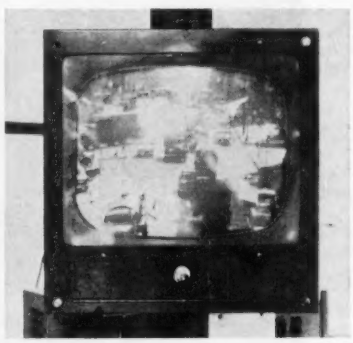
Industrial Notes

(*Continued from page 14A*)

New Location. Because of the continued growth of its business and in order more conveniently to serve its customers in the New York area, The Metals and Controls Corporation of Attleboro, Mass., is moving its New York sales office as of October 15th to larger quarters at 1 East 42nd Street, New York, N. Y. The new office will serve both the General Plate Division and the Spencer Thermostat Division of the Corporation. The Spencer Thermostat Division specializes in the manufacture of precision switches, thermostatic devices, aircraft and automotive circuit breakers, and is the major supplier in the United States of motor overheat protective devices. The new office will be staffed with an experienced group of sales personnel.

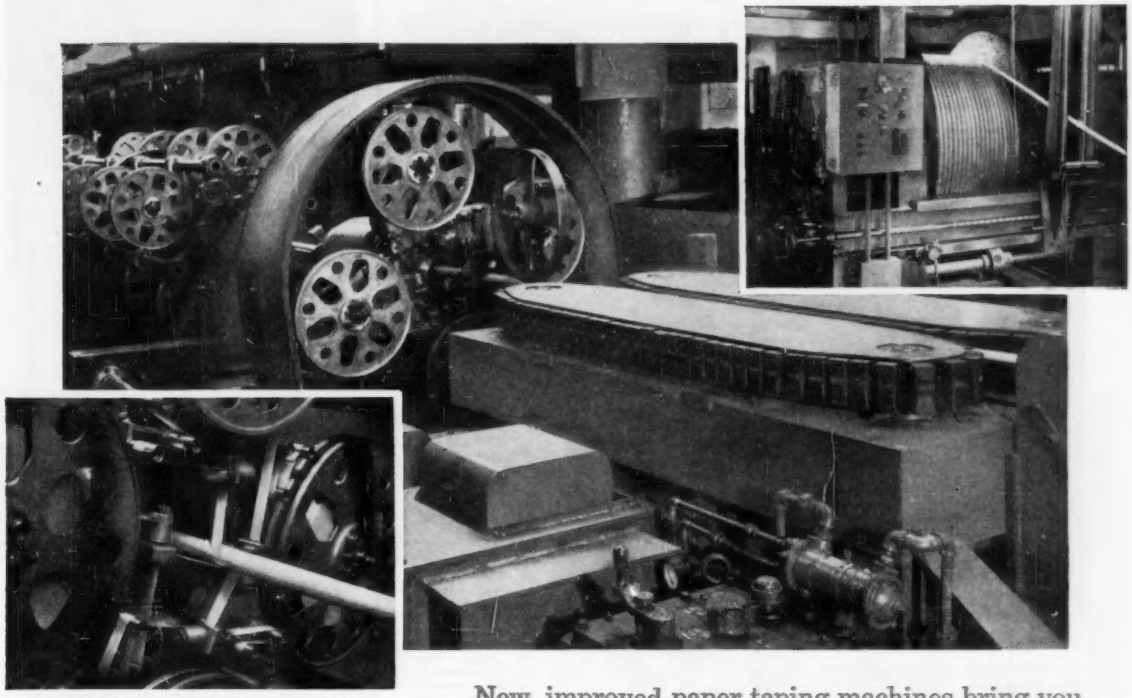
TV Assists Traffic Study. The Port of New York Authority and General Precision Laboratory, Pleasantville, N. Y., currently are conducting a joint test under actual operating conditions of the use of closed-circuit television to direct and monitor traffic, particularly in connection with the Port Authority's future requirements for the third tube of the Lincoln Tunnel. For the 30-day test period, General Precision Laboratory's 5-pound television camera in a weatherproof housing has been mounted in a fixed position on the exit ramp of the Port Authority's bus terminal leading into the Lincoln Tunnel. Looking south from the center of Tenth Avenue, the camera provides a continuous picture of traffic conditions from north of 38th Street, south to 35th Street. This view is sent over 750 feet of cable to the police control booth at the New York entrance to the Lincoln Tunnel. A 17-inch monitor furnishes the officer with a view of traffic which he had



previously been unable to see because of building obstructions. The information obtained permits him to issue traffic control instructions by loudspeaker to officers stationed at strategic points in the area. The control officer regulates the opening and closing of the camera lens to meet changing light conditions. The equipment, which requires only four operating controls, is continuously in use from 9 a.m. to 11 p.m. by Port Authority police personnel.

(*Continued on page 20A*)

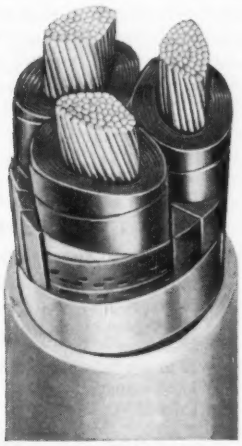
ROEBLING INVESTS IN YOUR FUTURE



MAIN PICTURE: Endview of taping machine showing caterpillar pull out

INSET AT UPPER RIGHT: Controlled tension take-up

INSET, ABOVE: Taping heads controlled tension



New, improved paper taping machines bring you far superior "paper and lead" cables

SHOWN ABOVE is one of the most modern paper taping machines in production today . . . applying tape to Roebling Paper Insulated Cables with an accuracy that brings new measures of insulating efficiency.

Outstanding features of these machines are:

★ Caterpillar pull-out which prevents distortion of paper tapes;

★ Improved gearing and "squirrel cage" machine design which eliminates backlash and insures uniformity in taping;

★ Controlled tension take-up which can be varied to suit the individual needs of each cable;

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★ Taping heads with automatic tension control.

The installation of this machine is just one part of a modernization program designed to give you paper insulated lead covered cables of outstanding dependability and service economy.

Let us consult with you on your individual cable problems. Our engineering and metallurgical staffs are always available.

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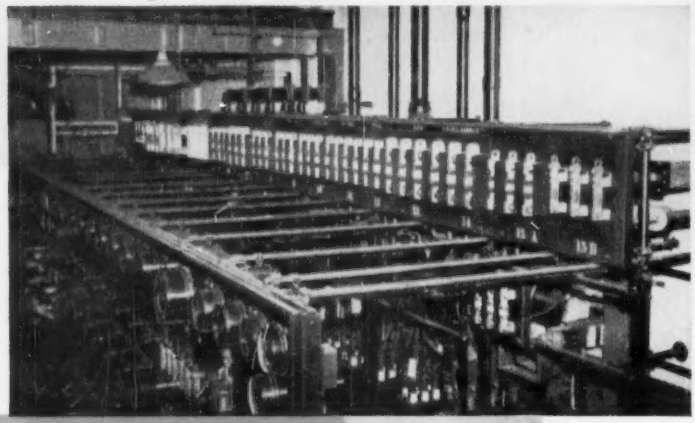
Anticipate* Destruction

Amp-trap PREVENTS DEVELOPMENT OF HEAVY SHORT CIRCUIT CURRENTS

* To preclude or prevent by prior action —" Webster



SHAWMUT Amp-trap*

"T. M. REG. U.S. PAT. OFFICE"

Amp-trap installation at Bird & Son, E. Walpole, Mass., raised the interrupting capacity of the system from 20,000 amperes to 100,000 amperes R.M.S. at 600 Volts, 60 Cycles.

NEW, LOW-COST SHORT CIRCUIT PROTECTION

Amp-trap, with its 100,000 RMS Interrupting Capacity, opens the circuit so fast that it *precludes* the development of the peak available short circuit current. Consequently, it *prevents* both magnetic and thermal destruction. Even phase-to-ground faults are cleared so quickly that multi-conductor faults are usually avoided.

CERTIFIED AND APPROVED

Amp-trap is listed by Underwriters Laboratories. Interrupting tests up to 202,000 amps at 500v 60 cycles have been witnessed and certified by Electrical Testing Laboratories, Inc. Amp-trap is favored by many insurance companies.

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Amp-trap is supplied in all standard ratings up to 4000 amperes for application on any circuit up to 600 volts AC or DC. It can be used on either old or new switchgear with a minimum of structural rearrangement. "Outage" time for installation is negligible. There is no better way to insure your investment in switchgear, buss-ducts, motor starters, circuit breakers and current transformers. Every service entrance on a network system needs Amp-trap protection. The list of Amp-trap users reads like the Blue Book of American industry. Investigate now.

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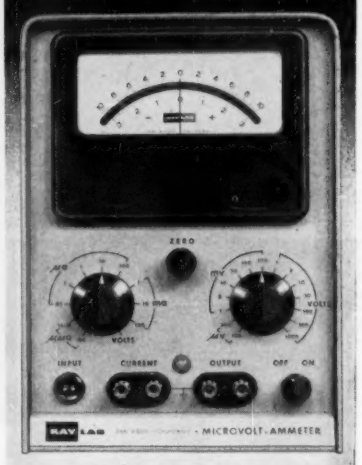

Universal DC Meter

This new microvolt-ammeter-amplifier will measure as little as 10 μv or 10 $\mu\mu$a with accuracy. It may also be used as a DC amplifier with up to 80 db gain and only 10 μv drift. A zero-center mirrored scale provides instant polarity indication. Utilization of Kay Lab's chopper stabilized circuit provides versatility, accuracy, and stability that is unobtainable with conventional VTVM's. The Model 203 is the ideal general purpose laboratory meter, production test set, or null meter.

SPECIFICATIONS

- 100 μv to 1000 v fs
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- 100 megohms input
- 80 db gain as amplifier
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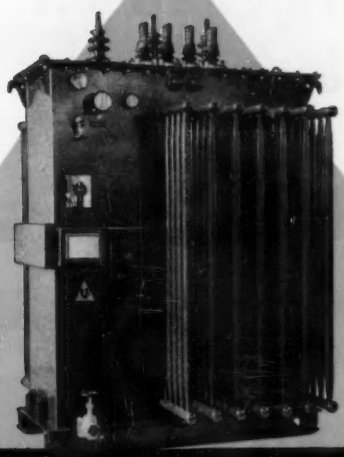

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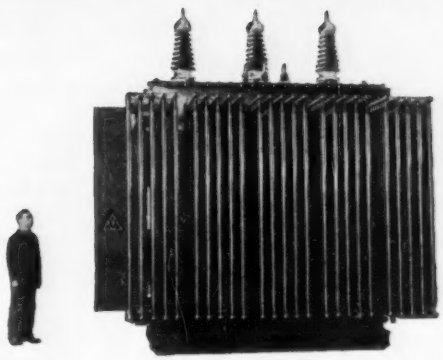
A complete engineering department and a modern, fully-equipped plant give Uptegraff the facilities it takes to provide fast service on power transformer production—even those of special design.

Available in sizes up to 10,000 KVA, 115 KV, every Uptegraff transformer meets or exceeds ASA, NEMA and AIEE standards and is fully guaranteed by our company.

These two advantages are yours when you order Uptegraff transformers for your power needs. And when the unit is delivered and installed, you have one of the finest built pieces of electrical equipment in the country—rugged, leakproof, undercoated, and performance tested.

You can order Uptegraff Power Transformers with standard accessories; terminal arrangement, cooling fans, wheels, oversize bushings and many other special accessories are optional.



If you're getting ready to replace or add to your transformer installations, Uptegraff can serve you well and quickly.

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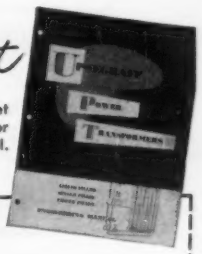

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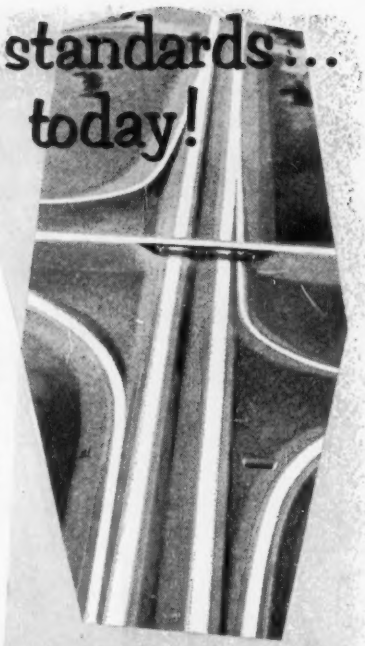

The Ohio Turnpike is the newest link in a national chain of superhighways that will eventually tie East to West. The most modern concepts of traffic engineering are reflected in the construction of this magnificent road. What transformers are used for service and lighting? Marcus, of course!

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Peterson-Webster Electric Co.
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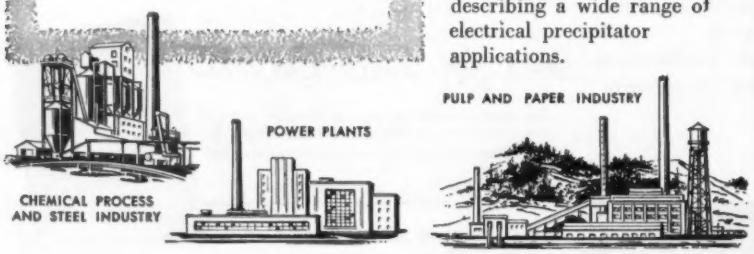

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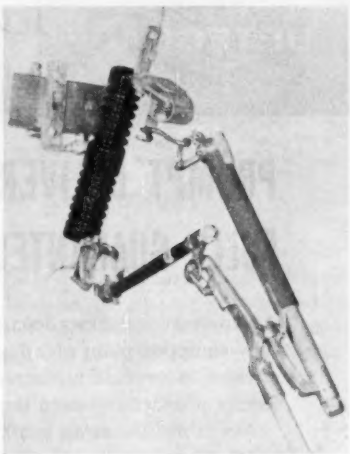
RC 127 *228 N. La Salle St., Chicago 1, Ill. • 111 Sutter St., San Francisco 4, Cal.*

(*Continued from page 16A*)

NEW PRODUCTS

New Concept in Load Switching. A portable loadbreak tool, known as "Loadbuster," can be carried conveniently on utility line trucks and applied instantly to any S&C Electric Company disconnect or cutout on a distribution system to break load current. By means of this tool, which may be used over and over again, every disconnect and cutout on a system may be operated as a load interrupter switch. Complete safety is afforded the lineman performing the opening operation, since there is no external arc resulting from the load interruption. The cost of providing this universal load interrupting facility is held to a bare minimum, since one Loadbuster has the repetitive capability of opening load currents with any number of switching devices. Attached quickly to a universal pole, the Loadbuster can be



manipulated freely, approaching the disconnect or cutout to be opened from any angle, direction, or distance. It is light in weight. To break load, the tool is simply hooked across the upper contacts of disconnect or cutout which is then opened in the normal way. There is no external arc, link breakage, contact burning, or danger to the operator. A simple twist of the pole disengages the tool, releasing it for immediate loadbreak service elsewhere. The tool provides arc-free circuit interruption at any distribution system voltage through 14,400 volts. It is able to break all load currents through 400 amperes, as well as associated magnetizing and charging currents. Moreover, it can switch all pole-top capacitor banks. For further information write to S&C Electric Company, 4435 N. Ravenswood Ave., Chicago 40, Ill.

Electronic Typewriter. Electronics now has been introduced to the typewriter. The result is that this oldest and most used office machine has learned to "read" while it writes. The "reading" typewriter was

(*Continued on page 26A*)

GENERAL CABLE'S

HIGH QUALITY CONTROL CABLE with

IMPROVED COLOR CODING

To preserve the superior physical characteristics inherent in black neoprene, General Cable applies a colored synthetic rubber base coating supplemented, where necessary, by spiral striping over the black neoprene jacket of individual conductors.

This new, carefully developed method of color coding the individual conductors of multiple conductor cable results in superior quality, brighter colors and an extra tough coating for permanence.

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New York 17, N. Y.
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Coast-to-Coast.

for quality and service . . . specify **GENERAL CABLE**

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for **ELECTRON TUBES**

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You should qualify in any **3** *of the following areas:*

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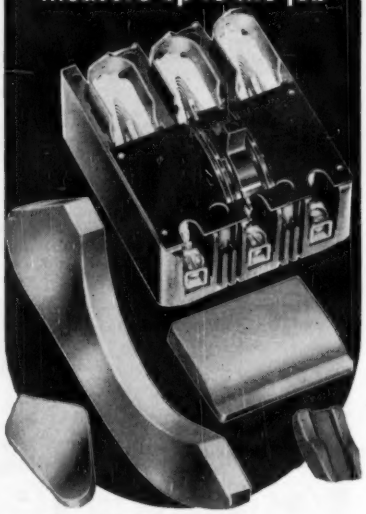

- **FOR CIRCUIT BREAKERS**
  The rigid requirements of circuit breakers — compact design, low temperature rise, high interrupting capacity — demand Gibsiloy silver-tungsten electrical contacts.
- **RIGHT PROPERTIES**
  These Gibsiloys have low contact resistance, high current-interrupting capacity, non-welding and other properties which mean trouble-free breaker operation.
- **FLEXIBILITY**
  Gibson's large range of silver-tungsten metal combinations and forms—plus our engineering skill in adapting the right contact to your product—can be a vital asset to you.
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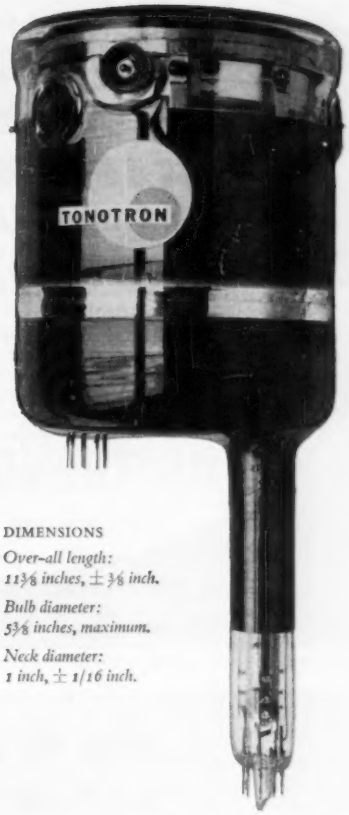
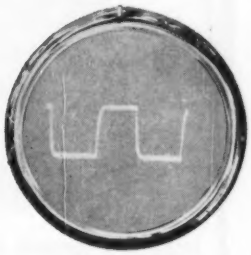


DIMENSIONS

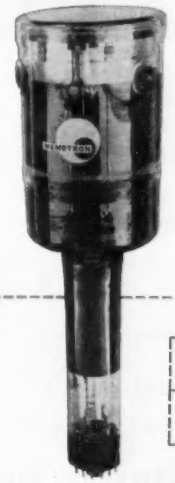
Over-all length:
11⅜ inches, ± ⅜ inch.

Bulb diameter:
5⅜ inches, maximum.

Neck diameter:
1 inch, ± 1/16 inch.



Single transient pulse, 20 microseconds wide with a one microsecond rise time, showing writing capabilities of one million inches per second. This photo was taken in full daylight without a hood.



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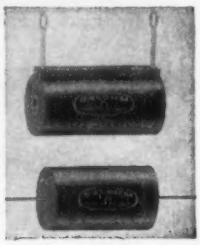

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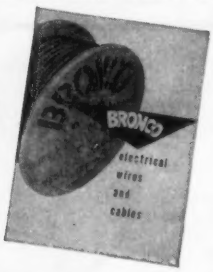

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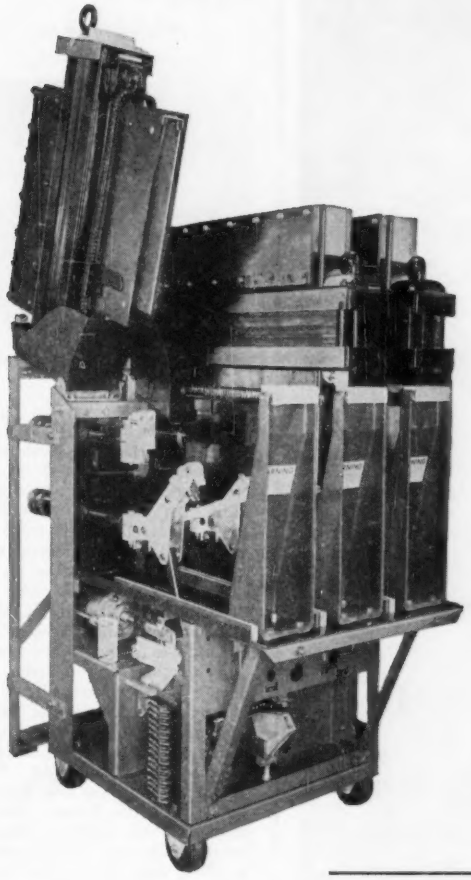


A Complete Line of I-T-E Metal-Clad Circuit Breakers for Every Application

Anticipating the proposed addition of three new higher metal-clad switchgear ratings, I-T-E now has a complete line of circuit breakers which are fully developed and tested to meet every requirement.

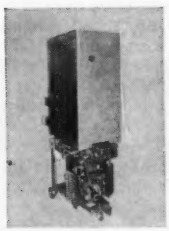
New 75 mva interrupting rating for I-T-E metal-clad switchgear applied on 4.16 kv systems

New 350 mva interrupting rating with a new 3000 amp continuous rating for application on 2.3 or 4.16 kv systems

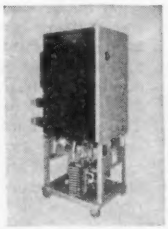
New 750 mva interrupting rating for application on 13.8 kv systems at 1200/2000 amp continuous

I-T-E Type	Continuous Amperes	Rated KV	Interrupting MVA
5HV-75	**1200**	4.16	**75**
5HV-150	600-1200-2000	4.16	150
5HV-250	1200-2000	4.16	250
5HV-350	**1200-3000**	4.16	**350**
7.5HV-250	1200-2000	7.2	250
7.5HV-500	1200-2000	7.2	500
15HV-150	600-1200	13.8	150
15HV-250	1200-2000	13.8	250
15HV-500	1200-2000	13.8	500
15HV-750	**1200-2000**	13.8	**750**

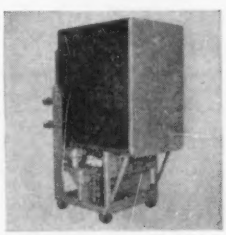
Note: These ratings require no change in I-T-E compartment dimensions.



5HV-75



5HV-350



15HV-750

For complete information, call your nearest I-T-E sales office. Or write I-T-E Circuit Breaker Company, 19th & Hamilton Streets, Philadelphia 30, Pa.

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Look at the Record
Look at the record of Hathaway's engineering know-how, achieved through years of experience in the automatic oscillograph field . . . Then look at the records taken by the new Hathaway RS-9 Fourteen and RS-9 Thirty.
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1315 SOUTH CLARKSON · DENVER, COLORADO

New Products

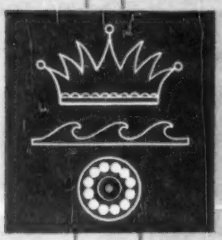
(*Continued from page 20A*)

unveiled by the Electric Typewriter Division of International Business Machines Corporation (IBM), 545 Madison Ave., New York 22, N. Y., when it announced the new IBM Electric Typewriter with electronic tabulation. The machine's "reading" ability will be of great assistance to the typist and will make her work considerably less tedious. The new typewriter feature specializes in the "reading" of prepared business forms which contain blank fill-in areas for the entry of date, order number, address, terms, and similar data. The electronics "reading" feature of the new IBM typewriter eliminates time consuming tabulating adjustments no matter how many different types of forms are placed in the machine. The new device works with business forms on which vertical lines are printed with electrically conductive ink, make the form sensitive to electric impulses. These conductive lines, in effect, program the typewriter. When the tab key on the keyboard is depressed, a tiny sensing unit close to the paper "reads" the form and automatically positions the typewriter carriage at the correct typing point. The electronic unit is mounted beneath the keyboard and is confined to a small metal container within the case.

Tachometer. A complete line of motor testing dynamometers featuring a new electronic tachometer has been put on the market by Magtrol, Inc., Buffalo, N. Y. The dynamometers feature a basic system of torque indication, independent of speed, rotor bearing friction, and external sources of mechanical or electrical error. Pendulum weights, attached at the outer periphery of the hysteresis brake of the dynamometer, balance against the actual running torque delivered from the test motor. This torque is read on a large, geometrically divided torque dial which also is mounted on the brake assembly and swings with it. The entire brake assembly is carried on two stainless steel ball-bearings, with extremely small static torque drag. In this way rotor bearing drag is included in torque readings, while carrier bearing drag is minute and negligible. There is no error due to the tachometer generator, since a photoelectric pick-up is used which requires no driving torque. The electronic

(*Continued on page 30A*)

Congratulations!



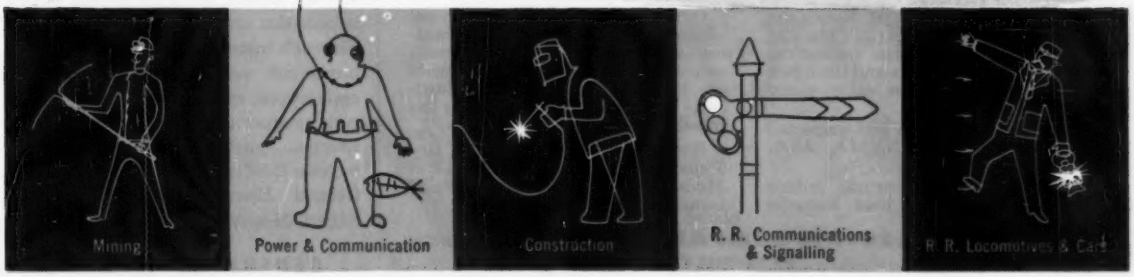
. . . to the American Telephone & Telegraph Company upon the completion of the new Transatlantic cable linking Europe and America.

This engineering achievement, the result of cooperative American and British enterprise, signalizes a new era of greatly improved Transatlantic telephone service.

Simplex Wire & Cable Co., as manufacturer and supplier of the American-made part of the submarine cable used in this gigantic project, is understandably proud to have participated in this historic accomplishment, and in the development work which made it possible. **SIMPLEX WIRE & CABLE CO.,** 79 Sidney Street, Cambridge 39, Mass.

Simplex

Wires and Cables for:



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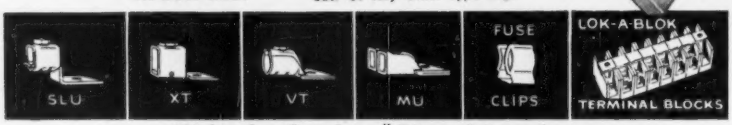

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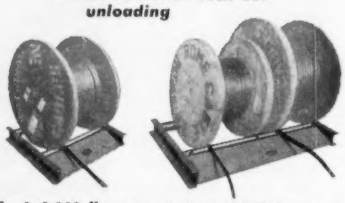

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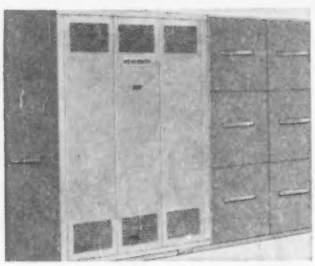

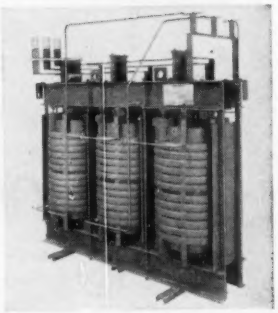

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Our engineers will be glad to cooperate with you in designing transformers to meet your exact specifications. Hevi Duty Transformers are built to the highest standards and are delivered promptly as scheduled.

Write today for our guide on "Dry Type Transformer Operation and Maintenance," a valuable source of transformer information.

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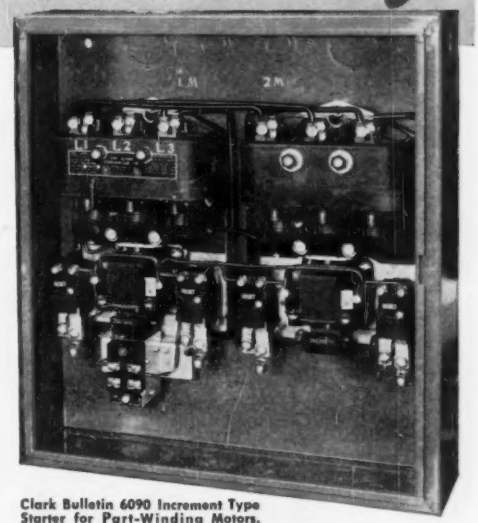
Now available, this complete and concise 40-page catalog gives condensed buying information on more than 75 of General Electric's instruments for laboratory and production testing. Brief descriptions, applications, specifications and prices for each product enable you to make your selection quickly and easily. Request bulletin GEC-1016 from Section 585-53, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

Two Outstanding CLARK CONTROLS for *"Cushioned" Motor Starting*

CLARK Increment Starters for Part-winding Motors and CLARK Reduced Voltage, Primary-resistor Type Starters are ideal for providing "cushioned" acceleration where requirements of the mechanical or electrical system indicate reduced torque-and-current starting. Both types offer the advantage of smoother acceleration and power application since the motor is not disconnected—eliminating mechanical and electrical shocks on the second step of acceleration. Both are available in sizes 1 through 7, with sizes 4 and smaller using the famous Clark Type "CY" starters which are setting new standards for dependability, low maintenance, and long life. Compact enclosures feature "safe-edge" design and generous wiring space.



Clark Bulletin 6090 Increment Type Starter for Part-Winding Motors. Integral Hinged Cover not shown.

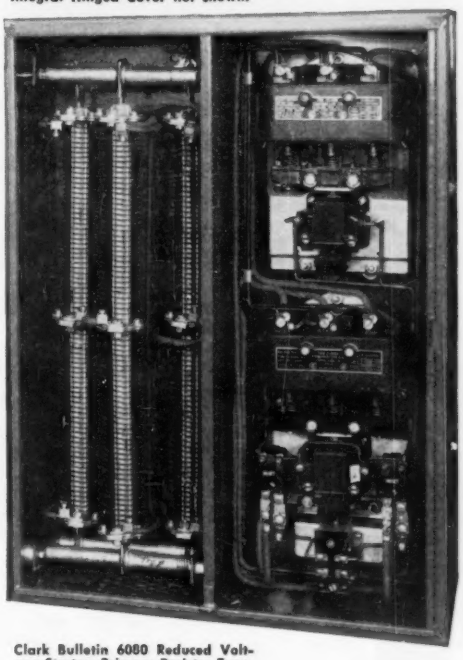
CLARK INCREMENT STARTERS FOR PART-WINDING MOTORS

Where part-winding motors can be used, this starter offers definite economical advantages. Because it has no resistors and uses smaller size contactors, a single compact enclosure reduces space requirements, and the initial cost is low compared to other types.

CLARK PRIMARY-RESISTOR TYPE REDUCED VOLTAGE STARTERS

This starter is applicable where higher starting torque is required. It offers greater flexibility of starting requirements and can be used on any squirrel-cage motor. It features the CLARK Edgewound non-breakable resistors—contactors and resistors are mounted in isolated compartments—where both are readily accessible.

For complete information on Clark Controls for "Cushioned" Starting, contact your nearest Clark sales office or write us direct.



Clark Bulletin 6080 Reduced Voltage Starter—Primary Resistor Type. Integral Hinged Cover not shown.

The **CLARK CONTROLLER** *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

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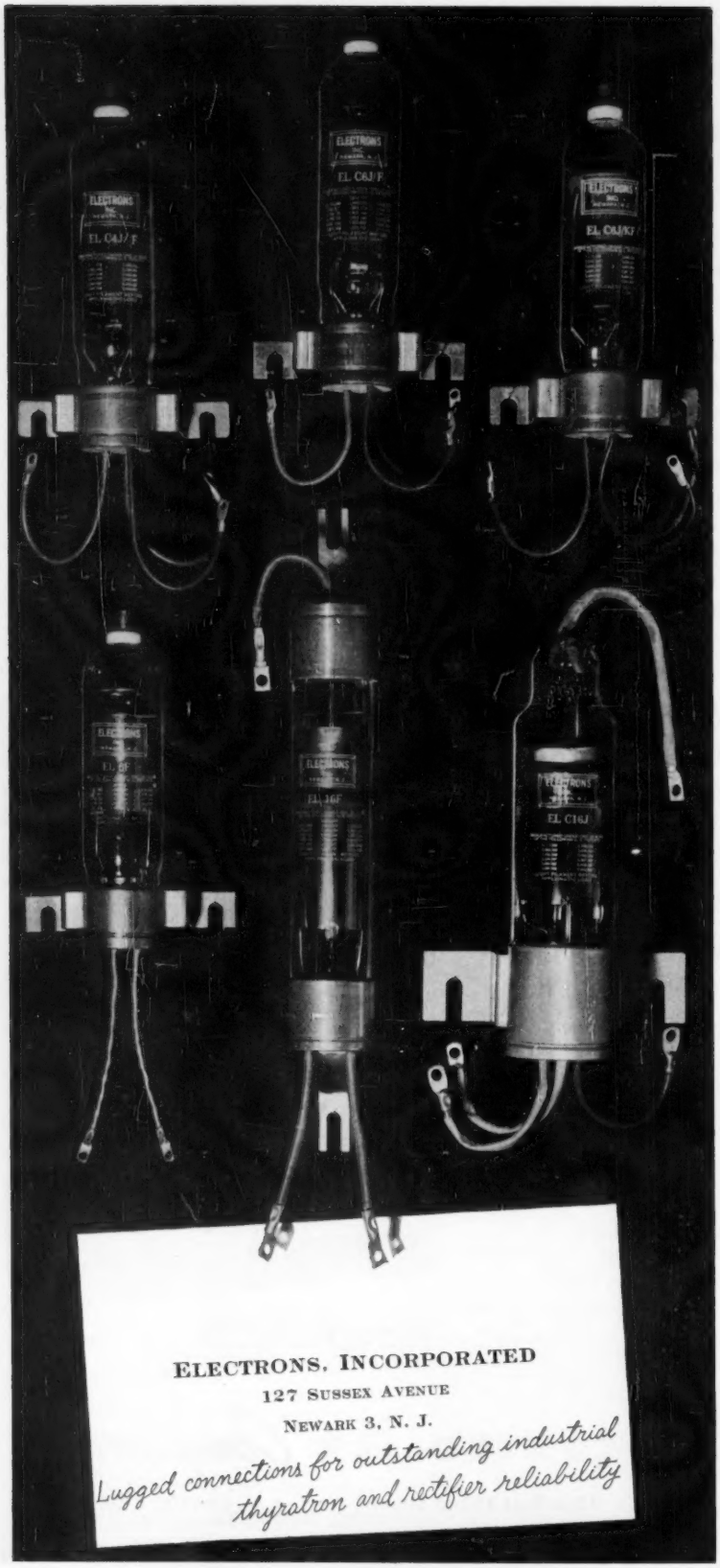


New Products

(*Continued from page 26A*)

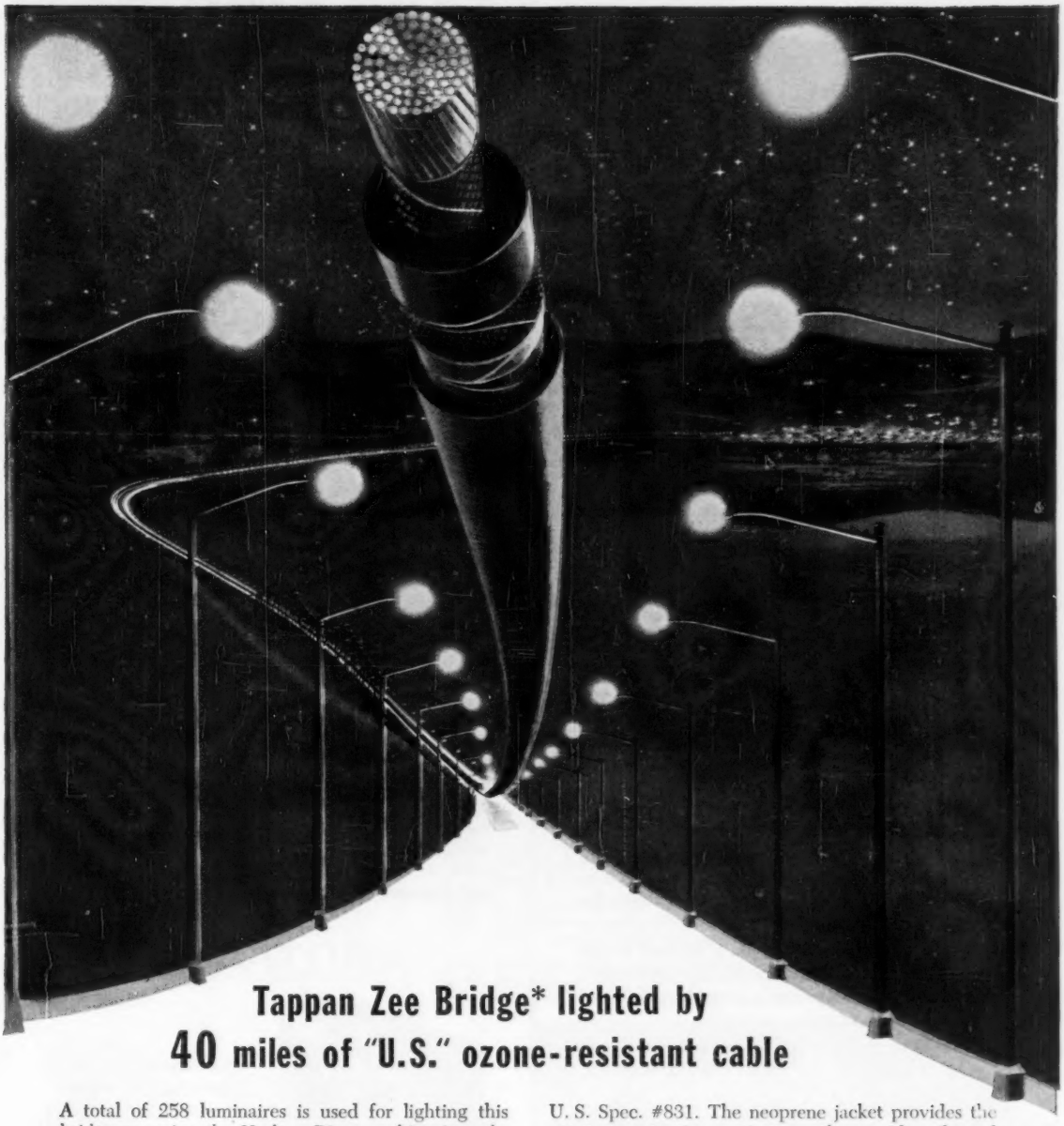
tachometer basically is a 4-digit glow transfer-tube counter, with a cycle timing gate to control the count-read-reset cycling, using photoelectric pickup on the rear of the dynamometer. The tachometer unit also encloses the electronic control for the dynamometer brake. Speed accuracy is guaranteed to one-half of 1 per cent of full scale on 60 cycle supply reference. Magtrol emphasizes that their dynamometers require absolutely no recalibration after leaving their plant. Accuracies listed are guaranteed. For complete information write to Magtrol, Inc., 38 Virginia Place, Buffalo 2, N. Y., for Catalogue *CBD*.

Motor for Direct Drive. Heating, ventilating, and refrigerating appliances are now being equipped with direct drive blowers powered by the new type *CY* permanent split capacitor MicroMotor manufactured by Redmond Company, Inc., Owosso, Mich. This new motor incorporates several design advantages such as no starting switches or relays, low starting current, low running current, high power factor, high efficiency, and gradual torque build-up. It is also suitable for multispeed operation, and any-position mounting. The motor stator is a "Uni-Cast" construction. This means the frame is die cast under high pressure to prevent shifting and vibration of laminations during manufacturing, handling, and motor use. Completed core, end bells, bearings, and shafting are precision machined to insure the quietest operation and longest life. The design is said to incorporate all of the latest mechanical developments proved by several years' acceptance of shaded-pole MicroMotors with similar design characteristics. The type *CY* permanent split capacitor MicroMotor is available in sizes from 1/10 to 1/3 hp. Engineering data and specifications are available on request.

Sealant. A 50 cubic-centimeter bottle of "Loctite," liquid lock for threaded fasteners produced by the American Sealants Company, Hartford, Conn., offers volume users a price reduction up to 33 per cent. Loctite sealant automatically hardens between mating metal surfaces, making ordinary fasteners lock-fasteners, and eliminating the need for lock washers and lock nuts. The new plastic bottle, five times larger than any size previously offered by the company, is primarily intended for the multiple application methods of tumbling, brushing, and dipping. A special applicator nozzle, packed with each carton, is supplied for those who prefer to use this larger bottle for the individual application method. Using the tumbling technique, the cost of treating 100 No. 6×3/8-inch machine screws is as low as nine cents. A continuing test program indicates that Loctite sealant may be safely stored in these larger bottles for extended periods of time, with a company guarantee of 90 days in the unopened container. Loctite sealant locks

(*Continued on page 38A*)

US RUBBER STREET LIGHTING CABLE



Tappan Zee Bridge* lighted by 40 miles of "U.S." ozone-resistant cable

A total of 258 luminaires is used for lighting this bridge spanning the Hudson River, making it probably the best-lighted bridge in the world. To minimize distribution costs, constant current series circuits are used.

The 40 miles of cable used on this lighting system is *ozone-resistant* "U. S." Series Street Lighting Cable, Uskorona – 2, butyl insulation, 7,500-volt shielded, U. S. Spec. #831. The neoprene jacket provides the greatest protection against weather, acids, oils and all-around abuse. Yet the cable is light in weight and easy to handle.

For electrical wires and cables to fill any requirement, to handle any wiring need, write Electrical Wire & Cable Department, United States Rubber Company, Rockefeller Center, New York 20, N. Y.

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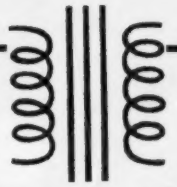
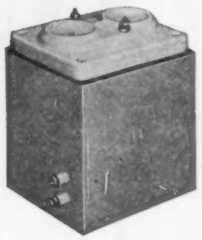
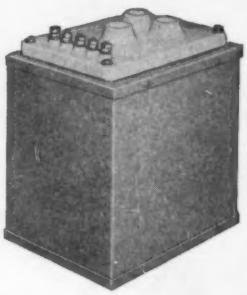


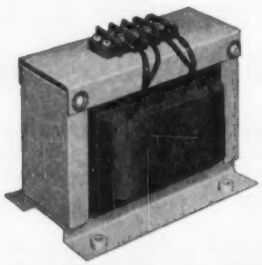
When dependable performance and long life are essential requirements of your transformer application—tell your problem to an Acme Electric transformer engineer. Chances are that sometime during our 39 years of manufacturing experience and development of more than 20,000 transformer designs we have had to solve a similar problem. Whether your need is for Miniature Pulse Transformers, Power Supply units or Power transformers up to 750 KVA, there's an experienced Acme Electric engineer to help you.



This filament Transformer was designed with particular stress on insulation. This design is insulated for 20 KV.



This Plate Transformer features a porcelain connection panel which in turn, is hermetically sealed to case.



This Saturable Reactor is simple and practical in design for easy installation and high performance.

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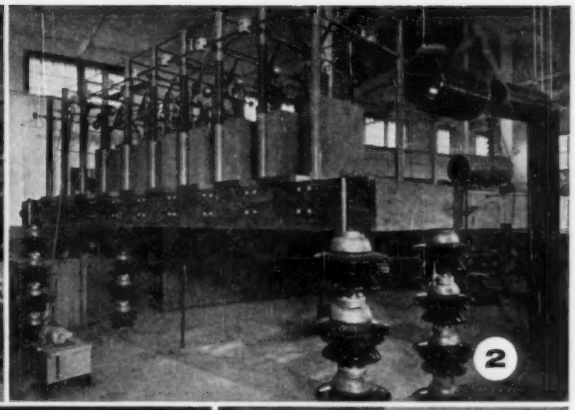
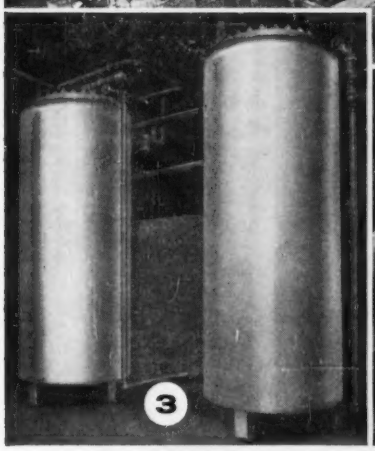
TRANSFORMERS





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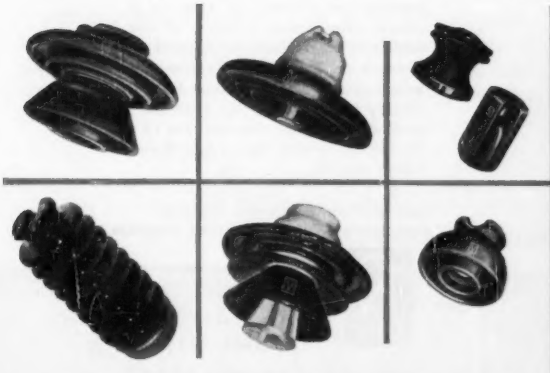
1. Demand for VICTOR Insulators has necessitated a continual plant expansion running into many millions of dollars. In the last seven years alone, our plant area has been increased 20% to provide greater space for manufacturing, storage and research!
2. This impulse generator in VICTOR'S electrical laboratory, enables our engineers to perform steep front wave tests as well as standard impulse tests.
3. All processing water used by VICTOR is demineralized. VICTOR was the *first* in the industry to install water demineralizing equipment. A patent on our process is now pending.
4. To certify insulator soundness, VICTOR uses black light. Unfired insulators are sprayed with fluorescent material, then subjected to a near ultra-violet light source.
5. This hydraulic testing machine in VICTOR'S specialty porcelain department gives open cutouts and similar insulators a routine calculated transverse load before electrical test.



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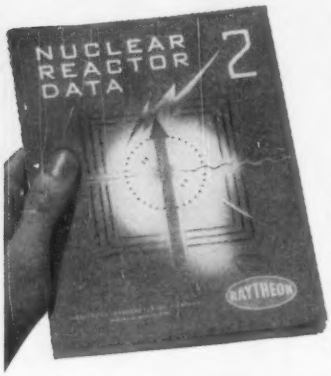

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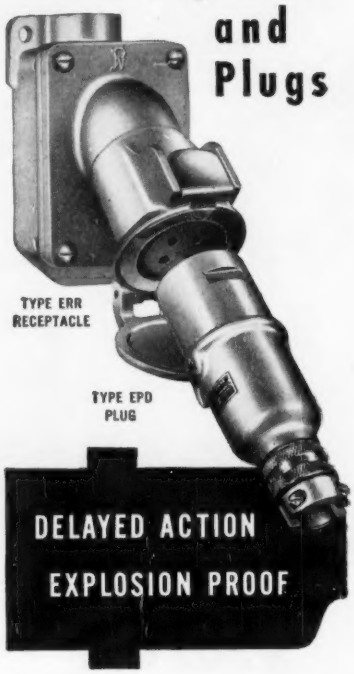

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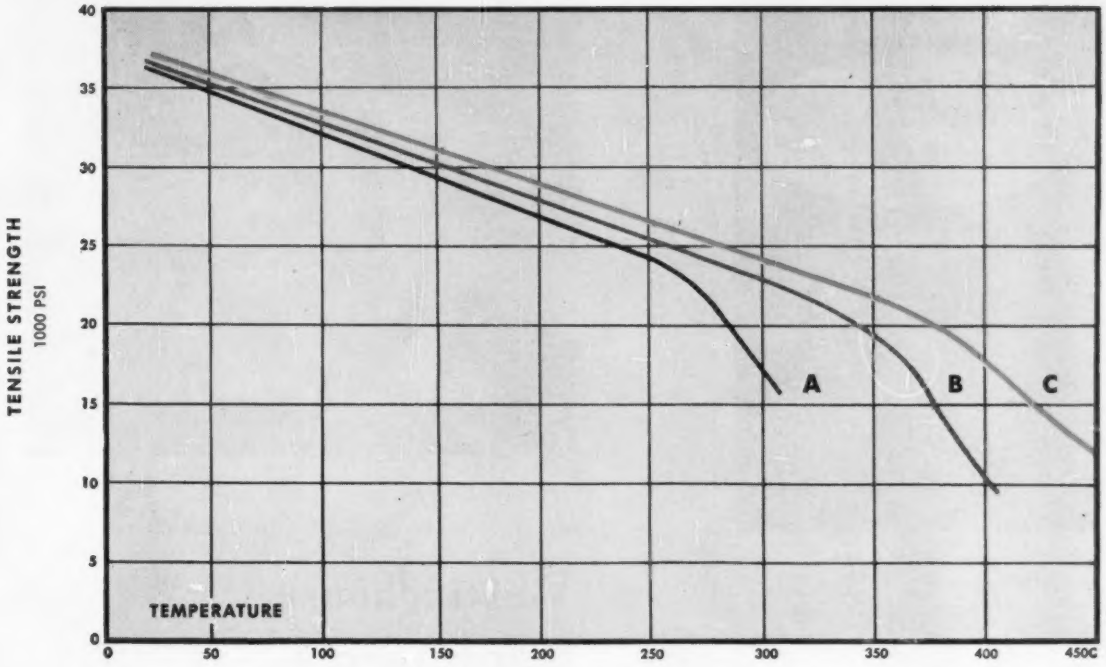
How silver helps copper conductors at elevated temperatures



THE INFLUENCE of silver on the tensile properties of high-conductivity copper at elevated temperatures. Tests made by the Metallurgical Research Laboratory of The American Brass Company. The test pieces were copper strips, cold-rolled to a temper approximately that of hard-drawn rectangular bus bar.
A. Electrolytic copper, silver content normal
B. Electrolytic copper, silver 8.7 ounces per ton added
C. Electrolytic copper, silver 28 ounces per ton added

In heavily loaded motors and generators, the windings, collector rings, and commutators must retain their strength at the higher operating temperatures that have become the rule. And there are now many other places where copper conductors must operate at temperatures well above those heretofore considered normal.

Electrolytic copper—with a very small amount of silver added—is superior to any other commercial conductor metal for use at these higher temperatures. Anaconda silver-bearing copper retains the structural design strength of the conductor at the higher operating temperatures. Annealing temperature is raised and softening delayed. The margin of safety is improved. How much gain you can count on is indicated by the chart above.

More complete information is available in the brand-new Fifth Edition of The American Brass Company's Publication C-25, "Anaconda Copper for Electrical Conductors." In addition, this 62-page booklet has convenient new tables giving physical and electrical data on all types of rigid bus conductors for the most commonly used sizes—plus a wealth of general information on the properties of copper conductors.

TECHNICAL SERVICE. The assistance of Anaconda specialists in the selection of conductors to meet your special problems is available to you. For such assistance – or to get a copy of "Anaconda Copper for Electrical Conductors" – see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 56100

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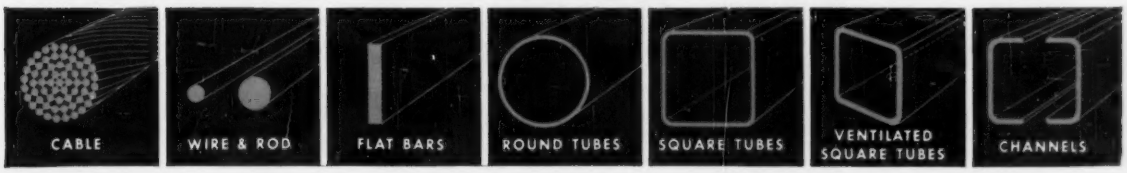
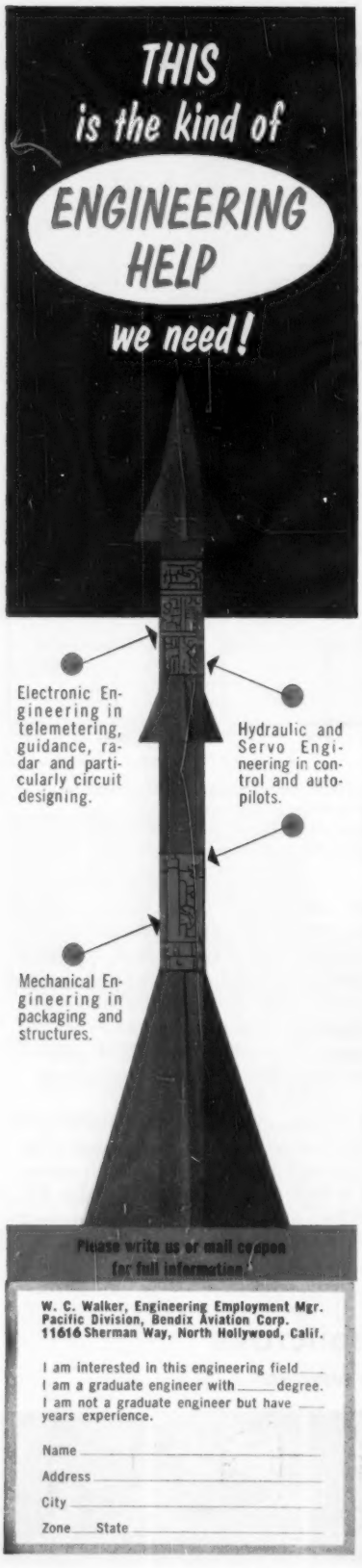
THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED

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A suggestion from
Dr. Robert J. Creagan, Project Manager

Westinghouse
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"In addition, reactor control problems with respect to transients are important. The reactor control must be integrated with the transient response of the entire power plant. Mathematical analysis using analog and digital computers is an important part of the work. We'd welcome an opportunity to discuss these interesting phases of our work with you."

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Please mail résumé of your professional and business background to: C. S. Southard, Westinghouse Commercial Atomic Power, Box 355, Dept. 113, Pittsburgh 30, Pennsylvania.

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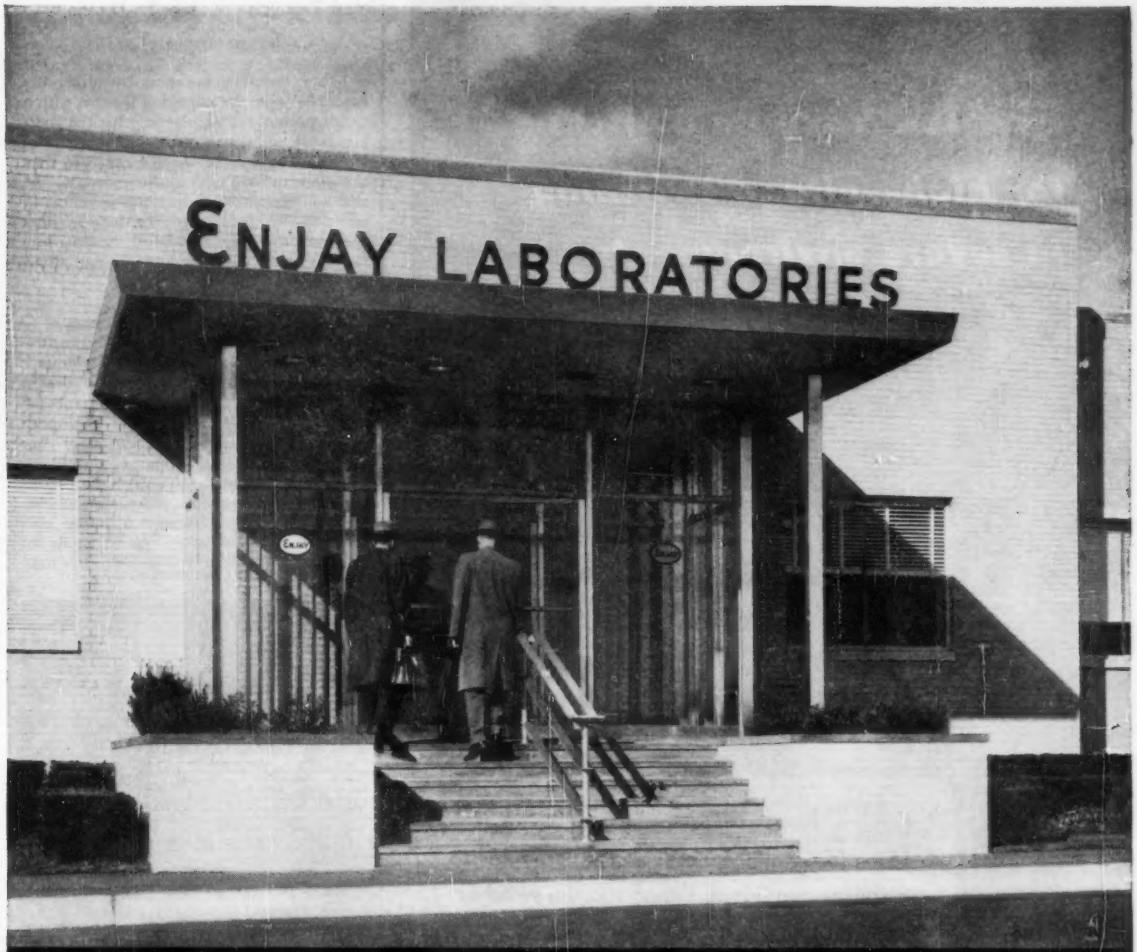

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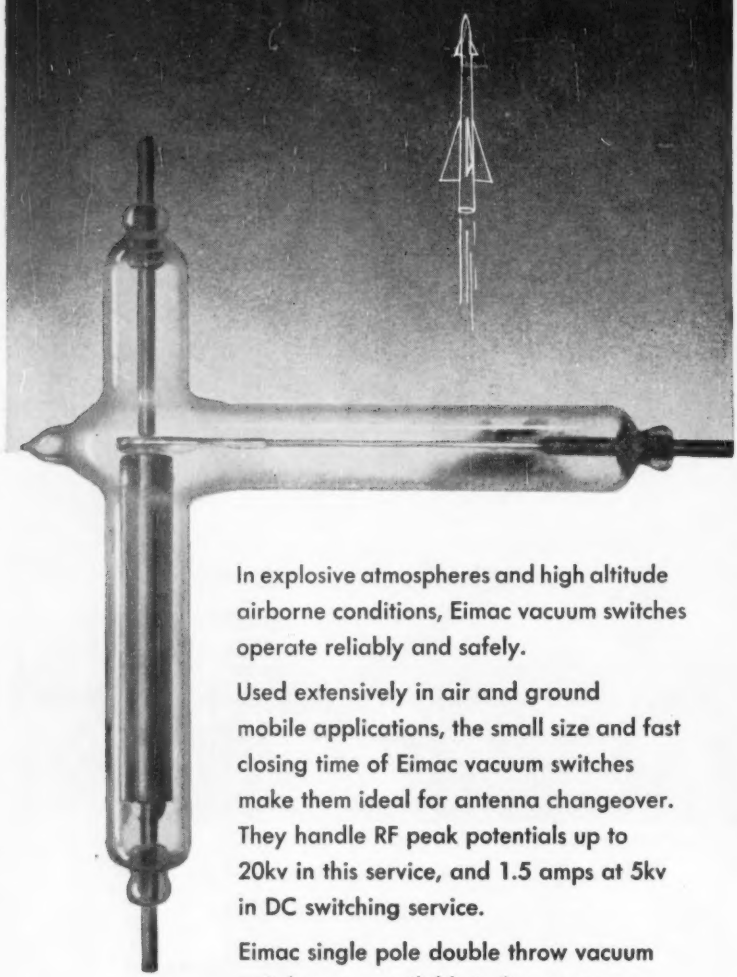
for high-voltage switching in severe environments.



In explosive atmospheres and high altitude airborne conditions, Eimac vacuum switches operate reliably and safely.

Used extensively in air and ground mobile applications, the small size and fast closing time of Eimac vacuum switches make them ideal for antenna changeover. They handle RF peak potentials up to 20kv in this service, and 1.5 amps at 5kv in DC switching service.

Eimac single pole double throw vacuum switches are available in four types, including one for pulse service.

If you have a switching problem, write our Application Engineering Department for further information.

Eimac

EITEL-McCULLOUGH, INC.

SAN BRUNO CALIFORNIA

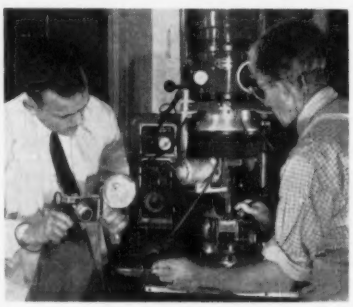
The World's Largest Manufacturer of Transmitting Tubes

New Products

(*Continued from page 30A*)

ordinary threaded fasteners by filling the spaces between the engaging threads with a tough plastic. This plastic grips the mating parts so securely that no amount of vibration can shake them loose, yet they can be removed with ordinary tools. In addition, Loctite sealant holds fasteners in any position on the threaded length, does not score threads, and seals the seating surfaces against dirt, corrosion, and fluid pressure.

Versatile Camera for Business and Industry. The Signet *40* camera, a moderately priced miniature camera of new design that provides a versatile instrument for either the experienced or the beginning business or industrial photographer has been announced by Eastman Kodak Company, Rochester 4, N. Y. Office procedures, training slides, employee photographs, assembly techniques, safety pictures, and many other photographs of growing value to business and industry may



be made easily in either color or black and white with the Signet *40*. The 35-mm camera is unique in that the camera and flasholder are, for the first time, styled as an integrated unit. An exposure guide for use with either color or black-and-white film under existing daylight conditions is part of the camera, while a simple exposure guide for use with various combinations of flash lamps and films is part of the flasholder.

Test Bench. Providing complete facilities for testing and quality control of electrical components, a universal test bench has been introduced by Performance Measurements Company, 15301 W. McNichols, Detroit 35, Mich. The bench incorporates a variety of instrumentation for the measurement of speed, time interval, voltage, current, resistance, power, torque, etc. An individual plug-in fixture is designed for each component to be tested. When the component design is changed, new test requirements are accommodated by simply changing the fixture; it is never necessary to rework the master bench. This flexibility makes the bench particularly suitable for production testing and receiving inspection work in the automotive and aircraft industries where design changes are frequent.

(*Continued on page 40A*)

AIEE SPECIAL PUBLICATIONS

To meet a specialized need, or where it has become advantageous to collate a number of papers on a subject in one pamphlet, a series of special publications has been established. Prices quoted are (M) for AIEE members, and (N) for nonmembers.

		PRICE M	N
S4	Advanced Methods of Mathematical Analysis as Applied to Electrical Engineering (1942)	.50	.50
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S60	CIGRE Report on Corona Losses (7/52)	.75	.75
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S2	Grounding Principles and Practice (6/45)	.50	.50
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S37	Lightning Reference Bibliography (4/50)	.35	.70
T78	Magnetism and Magnetic Materials Conference (6/55)	8.00	8.00
S28	Mathematics for Engineers	.15	.30
S65	National Telemetering Conference—1954	2.00	2.00
T80	National Telemetering Conference (5/55)	3.50	3.50
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S5	Ultrashort Electromagnetic Waves (9/43)	.50	.50
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*An AIEE Conference Report, consisting of the full texts of the papers and discussions presented at a special AIEE technical conference on the subject.

Also available is the following publication, issued by EJC (Engineers Joint Council) of which AIEE is a member:

S13	Engineering Profession in Transition (1947)	.50	1.00

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(CONTENTS—PRINTED MATTER)

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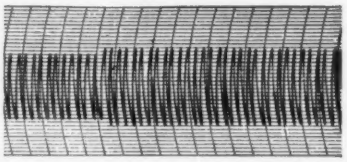
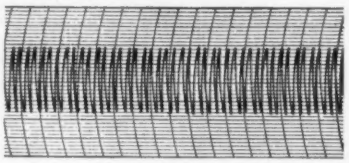
Regulation in *less than 1/50th cycle...*



Output of typical electromechanical regulator in response to step change in input voltage. Average correction rate of 6v. per sec.



Output of Curtiss-Wright Distortion Eliminating Voltage Regulator from same input. Full recovery in 330 microsec.

Simultaneous two-pen recording of 60 c.p.s. voltage

PLUS Pure Sine Wave Power

CURTISS-WRIGHT LINE REGULATOR

- **Electronically regulates r.m.s. and peak voltage simultaneously to ±1%.**
- **Reduces typical power line distortion to less than 0.3%.**
- **Furnishes 1.4 KVA of distortion-free power.**
- **Introduces no phase shift between input and output.**
- **Simultaneously provides additional 4 KVA of ±1% electromechanically regulated power.**

Faster recovery time (less than 1/50th cycle, or 330 microseconds) plus the unique ability to *eliminate* line distortion – these are the reasons why the Curtiss-Wright Distortion Eliminating Voltage Regulator has been chosen by more and more laboratories and production test departments. Besides general laboratory use, this line regulator provides simpler, more accurate calibration of meters . . . better design of transformers, synchros, motors . . . easier testing of such components, with fewer rejects . . . easier, more accurate measurement of magnetic properties and receiver sensitivity . . . better a.c. computer performance . . . elimination of fast line transient effects. Write for details.

Electronic Component & Instrument Sales Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

(*Continued from page 38A*)

TRADE LITERATURE

Constant Voltage D-C Power Supplies. A booklet on fixed-output constant voltage d-c power supplies available on request is from Sola Electric Company, Chicago, Ill., manufacturer of constant voltage transformers and lighting ballasts. The booklet gives technical data for six, standard-design, regulated d-c power supplies for intermittent, variable, and pulse loads, or high-amperage loads. The text is amply illustrated with photographs, schematic drawings, and tables showing mechanical and electrical specifications and performance data. These d-c power supplies combine a constant voltage transformer, a germanium power rectifier, and high-capacitance filter without choke. Information of Sola's special design and assembly service for custom made units is included in the booklet, together with specific instructions on how to get additional data or estimates on special design problems. The booklet was eight pages, and is prepunched to fit a standard 3-ring binder. Write to Sola Electric Company, 4633 West 16th Street, Chicago 50, Ill., for bulletin *DC-235*.

Kitchen Equipment Book. The publishers of *Food Service* magazine have issued their fact book of commercial kitchen equipment, a reference book for manufacturers, dealers, food service operators, and for those in electric utilities. The book is 63 pages long and sells for $1. For further information contact Food Service Magazine, 2132 Fordem Ave., Madison 1, Wis.

Contacts, Rivets. This catalogue lists 300 standard contacts and rivets available in a wide range of precious and base metals, such as silver, gold, platinum, palladium, brass, steel, etc. Many variations of these standard sizes are available upon short notice. Many cold headed specialties are also illustrated. This catalogue is available upon request from Deringer Metallurgical Corporation, 8131 Monticello Ave., Skokie, Ill.

Laboratory Ware. A brochure describing standard and special form platinum laboratory ware has been recently published by General Plate Division of Metals and Controls Corporation. This booklet illustrates and describes standard and special form platinum crucibles and evaporating dishes. Miscellaneous platinum laboratory ware such as spatulas, triangles, breed loops, filter cones, etc., are also illustrated and described. Available sizes and weights are tabulated for ease in ordering. General Plate's refining facilities are described, with general information on the care and maintenance of laboratory ware. Write to Metals and Controls Corporation, General Plate Division, 43 Forest St., Attleboro, Mass.

(*Continued on page 44A*)

DOW CORNING CORPORATION

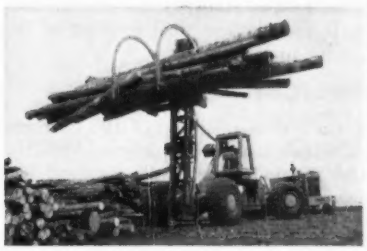
Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 9

Giant Log Stacker Attains Peak Power With Class H Motors

Engineers designing large electrically powered equipment are attaining more power per pound while gaining the many advantages of placing the power unit closer to the work by using motors insulated with Dow Corning Silicones. An excellent example is the giant Electric Log Stacker produced by R. G. LeTourneau, Inc., Longview, Texas.

A separate high torque a/c motor connects directly to every point of load — lift fork, hold-down tusks, boom tilt and rear axle steering. And there is a separate d/c motor inside each of the four rubber-tired drive wheels. A diesel-generator set supplies power to any or all motors on demand.



The work potential of these mechanical giants is worthy of Paul Bunyan. A single bite of the lift forks conveys up to 25 tons of logs; one stacker can move more logs in 5 minutes than three conventional yard lifts can handle in 30 minutes!

To provide maximum power and reliability, every working motor — like all drive motors on all LeTourneau "electric wheel" equipment — is Class H insulated with Dow Corning Silicones. *No. 35*

Encapsulating Electrical and Electronic Parts with Silastic is the subject of a data sheet that provides details of handling heat-vulcanizable and room-temperature-vulcanizable silicone rubbers in such applications. *No. 36*

All New — 1957 Guide to Dow Corning Silicones is a twelve page, fact-filled catalog which briefly describes the silicone products of interest to most industries. Containing latest data and information, the guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these unique engineering materials. *No. 37*

Improve Percolator With Silicone Laminate At No Extra Cost

Designers who make imaginative use of silicones to increase the life and reliability of toasters, steam irons and other appliances can often do so without adding a single penny to the cost of the finished product. A recent example is provided by Aluminum Goods Manufacturing Company, manufacturer of Mirro-Matic Percolators.

While Mirro-Matic's terminal pin insulators made of phenolic had proven satisfactory in normal use, the designers reasoned that abuse of the percolator could loosen electrical connectors and cause arcing. Phenolic is also prone to absorb moisture when splashed or dunked by careless users, raising a further possibility of insulator failure.

The risk of such breakdown, however, was entirely eliminated by the superior dielectric strength, heat and moisture resistance of silicone-glass laminates manufactured by Taylor Fibre Company. The moisture absorption of silicone laminate, for example, is only 0.02% compared with about 2% for phenolic.

And, because of the higher physical strength of silicone laminate, plain low cost stampings could be used instead of expensive molded parts. A further saving was produced by reducing breakage during assembly.

The score: greater reliability for the Mirro-Matic Percolator without adding a cent to production costs! *No. 39*

COIL BOBBINS OF SILASTIC RESIST HEAT, HIGH VOLTAGE

Combine high temperatures and high voltage and you'll quickly expose any weak link in an electrical insulation system. That's what happened when technicians at Transformer Engineers, Pasadena, California, tested conventional choke coils intended for use on aircraft fire control apparatus.

The tests revealed that conventional coil bobbins all too often developed "electrical punctures" in the tube-to-flange joints when subjected to 15,000 volts at 140 C operating temperatures.

The problem was overcome, however, with

bobbins molded in one piece of Silastic, the Dow Corning silicone rubber. Featuring excellent thermal stability and dielectric strength after prolonged exposure to high temperatures, their one-piece construction avoided tube-to-flange joints entirely. Over 3000 of them have been put into service in the last two years; not one failure has been reported to date. *No. 38*

Silicone Insulated Conductors, a reprint from WIRE AND WIRE PRODUCTS, describes and compares eight different types of silicone insulated wire and cable currently available for different applications. *No. 40*

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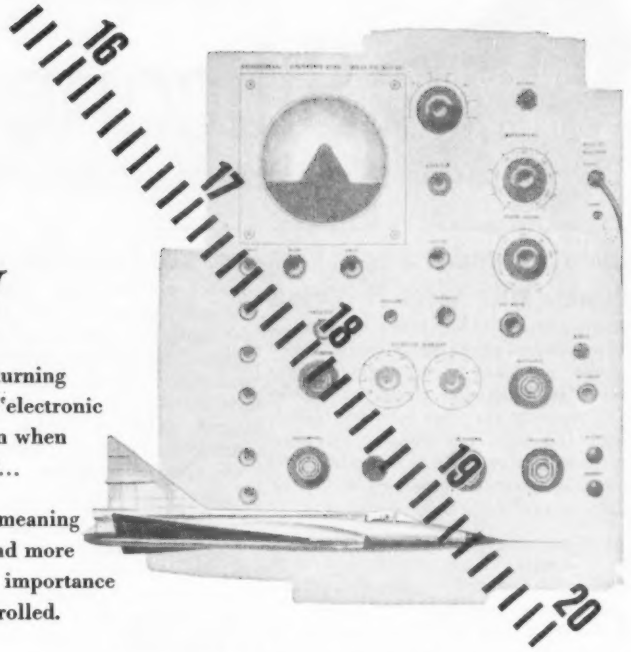
SECOND OF A SERIES

How to get reliability



Got the automation jitters?...worried about turning complex manufacturing operations over to an "electronic brain"?...worried about what can happen when one component in the control system fails?...

Reliability takes on a new and different meaning as American industry becomes more and more automated. Here are a few thoughts on the importance of reliability and how it can be controlled.

All of us are going to have to pay more attention to "reliability."

We'll have to pay more attention to individual "devices" within a system.

We'll have to guard ourselves carefully when we design the entire system.

The industrial pendulum is swinging more and more toward automatic controls, servo-mechanisms, computers, and automatic "watchers." As it does, the reliability factor becomes more and more important. Let's see why. For example, you probably have three radios at home. If one fails because a soldered joint comes apart, your home life is probably not disrupted to any alarming degree. But... consider the automatically controlled steel mill. One soldered joint failing, unless all controls are installed in duplicate (which is expensive) could tie up the entire production process for valuable minutes, if the maintenance crew has second sight. For hours, if automatic trouble-indicating and locating systems are not installed (and these are expensive, too). Last, but not least, lend a thought to the dependence of guided missiles and man-made satellites upon the reliability of electronic circuits and components. So... let's start to examine "reliability." Let's begin by looking at this definition which is currently popular in the technical field:

The reliability of a particular component or system of components is the probability that it will do what it is supposed to do under operating conditions for a specified operating time.

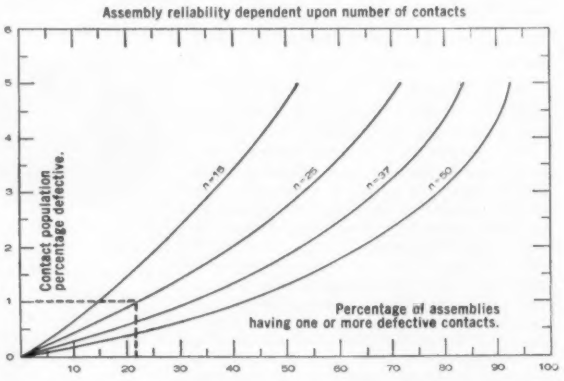
Now... this is a relatively well-accepted definition, and it offers the key to the problem of coping with failure control. Take the word "probability" in this definition. Let's discuss its implication.

Many of today's systems, simple or complex, are a chain of components. So picture a system as a chain with its successive links. In the field of statistics the over-all reliability of the chain is the mathematical product of the reliabilities of the individual links...

Overall Reliability, $R_o = r_1 \times r_2 \times r_3 \ldots r_n$

Now, let's consider a system made up of 100 different components, each of which has a reliability of 99%. In applying the formula, multiplication of .99 by itself 100 times gives an over-all reliability for the system of only 36.5%. Two out of three systems you have put together will probably fail!

Cannon becomes involved with this problem because our main business is making electric connectors. So, let's look at the following chart that covers contact reliabilities and reliability of the assembly in which they are mounted.



This chart illustrates the reliability of four connectors having 15, 25, 37 and 50 contacts respectively. As an example, assume that the contacts have a contact population of 1% defective (1 in 100 defective . . . this percentage is considered a fairly high standard in most fields). On the 15-contact assembly, we find from our chart that 14% of the connector assemblies would have one or more defective contacts! With 25 contacts, 22% would have one or more defective contacts. With 50 contacts, 41½% . . . is your hair starting to curl? Obviously, a 99% contact reliability standard for guided missile components is absolutely unacceptable. And, in between the simplest system and that of a guided missile, are hundreds of assemblies and systems whose reliability factors must be analyzed with utmost care.

But all is not lost! There's another side to the picture. With proper care, analysis, and control, our Cannon organization has actually achieved, in special "missile quality" contacts, a known level of only 2.85 x 10^{-3}% defective . . . only 1 part in 35,000! Naturally, we don't achieve that with all our contacts . . . but we do try to design and manufacture the utmost in reliability required for specific applications.

We have pictured this chart to show the direction we must all take, whether we're talking about connectors, other components, or systems. It boils down to two steps . . .

- The number (n) of components must be kept low . . . *simplicity.*
- The level of component reliability must constantly be improved . . . *hard work for all of us.*

Now . . . if we refer to our reliability definition on the previous page we note the phrase "do what it is supposed to do." So be sure *you* define these objectives for your component assembly, or system . . . failure to do so carefully can cause undue failure or the expenditure of unnecessary dollars for needless, excessively-reliable parts or design.

Further on in the same definition, we note the words "operating conditions." This brings up many new points for consideration. Here we are concerned with such things as temperature, pressure, humidity, corrosive atmosphere, stray electric and magnetic fields, low and high frequency noise, shock and vibration. Do your design standards need upgrading? Are your components designed and then tested to meet the operating conditions you specify . . . or are they designed to meet "average" conditions? Are you using adequate "safety factors"?

In a simple component, manufacturers have always looked for, recognized, and corrected faults when they occurred. We use component quality control to achieve and maintain Cannon's world famous product quality. But in complex systems such component quality control is not enough. Actually . . .

Reliability control over the system is needed. It should be all-encompassing. When you get right down to it, *reliability* is the product of procedures, equipment, and people . . . in the design, manufacture, testing, control of quality, transportation, and use of products or systems.

Do you have a reliability control system?

Here are a few of the steps that are needed to get a reliability control system operating:

1. Determine Your Requirements. Specify the environment, operating time, performance limits, and the percent of reliability required. Allow an adequate safety factor keeping in mind the end use of the finished product.

2. Collect Reliability Data. Set up facilities for the continuous accumulation of data on component or system failures and their causes.

3. Establish quality control and test procedures which show high degree of correlation with end-use conditions.

4. Analyze. Determine if reliability requirements are being met. Establish the most important causes of failure by analyzing the data you collect.

5. Improve. Take action to eliminate the most important defects or causes of failure. Reduce the failure rate to the required level.

6. Maintain Continuous Vigilance. You have emphasized system design . . . you have used statistical analysis of failures . . . now exert continuous and critical control to be sure your "improvements" actually improve reliability. Examine new and unforeseen failure sources. Review and modify your requirements with changing conditions.

*

We at Cannon Electric are proud of our historical emphasis on quality and reliability. Since 1915 we have adhered to a design philosophy embracing the highest quality and reliability in each and every Cannon Plug for the specific application for which it is to be used. *If we can't design to that principle, we don't make it!* In manufacture, we are proud of our know-how in depth, proud of our fine quality control systems, proud of our personnel and proud of our reliability control group.

Whenever *you* have an electric connector reliability problem . . . in design, engineering, production, or prototype phases . . . we would appreciate the opportunity of discussing it with you.

Cordially,

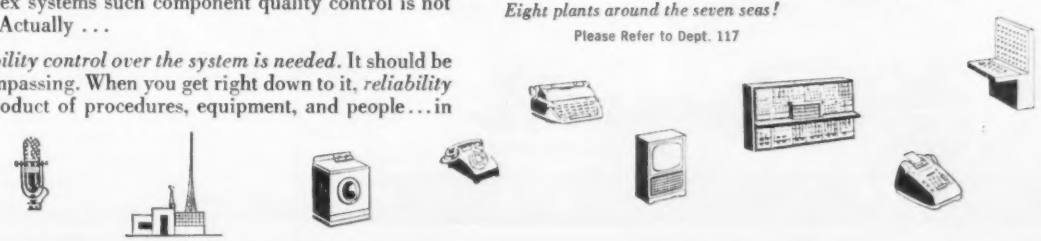
Robert J. Cannon *President*

CANNON ELECTRIC COMPANY
3208 Humboldt St., Los Angeles 31, California

CANNON PLUGS

Eight plants around the seven seas!

Please Refer to Dept. 117



They Go a Long Way

Morganite current collectors go a long way toward cutting expenses for crane operation and maintenance. The wear-resistant carbon inserts in **Morganite collectors** offer you a triple saving through . . .

- **LOW COST**
- **LONG LIFE**
- **LOW WIRE WEAR**

The initial cost of **Morganite collectors** is low. Maintenance is even less. Low-friction carbon inserts actually protect your wires as well as make highly efficient electrical contact. Dangerous arcing is eliminated, and precise control is possible throughout the long life of the collector.

You will find **Morganite current collectors** available for installation on a wide variety of cranes in mills and all types of heavy industrial plants.

50th ANNIVERSARY TRADE MARK 1906 · 1956

Morganite INCORPORATED

Manufacturers of fine carbon-graphite products for fifty years.
3308 48th Avenue, Long Island City 1, New York

Trade Literature

(*Continued from page 40A*)

Contacts. Publication of "The Wilco Tech Bulletin," to be distributed periodically to engineers upon written request, has been started. The first two issues of the bulletin will deal with silver-cadmium oxide electrical contacts, including the results of recent development work conducted in the firm's laboratory at Union, N. J. Engineers who wish to receive "The Wilco Tech Bulletin" should write The H. A. Wilson Company, 2655 U. S. Route 22, Union, N. J.

Research Bulletin. Facilities of the Allis-Chalmers Central Research Laboratories are described and portrayed in digest form in a 24-page bulletin released by the company. Covered are facilities involving electrical, mechanical, physics, nuclear, chemical, metallurgical, and processing research projects initiated to bring to the company's product and design engineers methods and processes that will help them in the development of new and better products. Copies of "Research at Allis-Chalmers," Bulletin *48B8448*, are available on request from Allis-Chalmers Manufacturing Company, 931 S. 70th St., Milwaukee, Wis.

Power Supplies File. Publication of a new custom design file illustrating the range and variety of custom power supply work done by the engineering staff of the NJE Corporation has been announced. Included are series-tube-regulated supplies, constant-current supplies, unregulated high-voltage power supplies, semiconductor brute-force power supplies, and thyratron-controlled supplies. Data given on each unit include voltage, current, ripple, line regulation, load regulation, and price. This publication is of particular interest to engineers and purchasing agents who may require custom power supply equipment, because it offers a ready and reliable means of estimating price and performance of noncatalogue equipment. Copies of the NJE "Custom Design File" can be obtained by writing to NJE Corporation, 345 Carnegie Ave., Kenilworth, N. J.

Technical Language Glossary. There are more than 300 words that describe the peculiar technology of coating blueprint and diazotype reproduction papers. A glossary of the technical terms involved in making such papers sensitive to ultraviolet light has been published by the National Association of Blueprint and Diazotype Coaters, 1001 Connecticut Ave. N. W., Washington, D. C. Compiled by the association's research and standardization committee, the glossary is the first effort to establish a common language for the industry whose products become the diazoprints and blueprints on which the ideas, designs, and drawings of business and industry are transmitted.

(*Continued on page 62A*)

What Does VACUUM Do For a Relay?

RE4
SPDT

RD1
N/O

RD2
N/C

RE2
SPDT

RE3
SPDT

JGF-RE2
SPDT

RM4
4PDT

RM2
2PDT

1 **A high vacuum positively insures clean contacts that stay clean. The high temperature processing required to achieve an insulating vacuum drives off all vapors that might contaminate the contacts. The permanent vacuum then keeps the contacts clean during their storage and service life since all sources of contamination (such as organic matter, metallic oxides, etc.) are excluded from the evacuated contact enclosure. Contact resistance actually tends to improve with use.**

2 **A high vacuum permits antennas, pulse forming networks, and dc circuits to be switched "hot" if necessary without the danger of sticking or welding. The arc time is less than in any other interrupting medium. Since there is nothing to burn or to ionize, arcing ceases as soon as the contacts are parted enough so that field emission is no longer possible.**

3 **A high vacuum is excellent high voltage insulation permitting the construction of small, efficient contact actuating mechanisms that resist vibration and shock forces.**

In Jennings' Transfer Relays this high vacuum is combined with an efficient magnetic circuit that has no air gap losses except those of the armature itself. Sufficient contact pressure is provided by the small 5 to 10 watt coil to permit rf current ratings of 10 to 15 amperes and contact resistances of less than .01 to .02 ohms.

Two new transfer relays have recently been developed by Jennings. The type JGF-RE2 relay is a 10 kv, 10 ampere RE2 vacuum relay enclosed in a rugged gas-filled container so that it can be mounted in exposed locations. The Type RE4 relay is for higher operating voltages up to 25 kv. It has a 5 watt actuating coil and like all Jennings transfer relays it has a simple flange mount so that the high voltage terminals can be sealed into a pressurized or oil filled container with the low voltage terminals and the coil accessible from the outside.

If you have difficult switching requirements that cannot be easily met by conventional relay types, we would like the opportunity of suggesting a suitable vacuum relay. Literature mailed upon request.

Jennings RADIO
VACUUM ELECTRONIC COMPONENTS

JENNINGS RADIO MANUFACTURING CORPORATION · 970 McLAUGHLIN AVE. P.O. BOX 1278 · SAN JOSE 8, CALIFORNIA

THE HOW AND WHY

OF THE WORLD'S PUREST SILICON

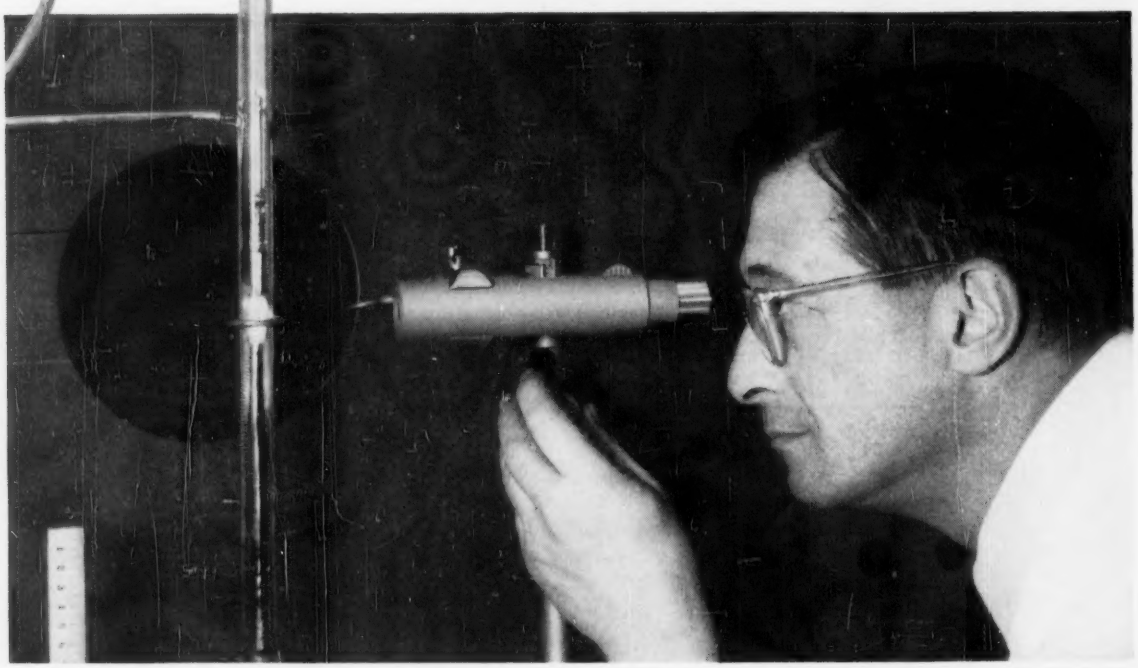
The purification of silicon by Bell Laboratories metallurgists has been richly rewarding. Their original research in this field revealed the chemical factors that control semiconductors; it was a major advance leading to Bell Laboratories' invention and development of transistors and the Bell Solar Battery. Now they have devised a simple but highly effective way to remove boron—one of the most difficult impurities to extract from silicon.

During refining, a stream of hydrogen and water vapor is kept flowing past the silicon. As the water vapor passes over the liquid silicon, it seizes boron atoms, forming boron oxide. The oxide is then pulled away to condense on the wall of the refining tube which is cooled by a water stream. Result of refining: boron and other harmful impurities are reduced to less than one part in 10,000,000,000.

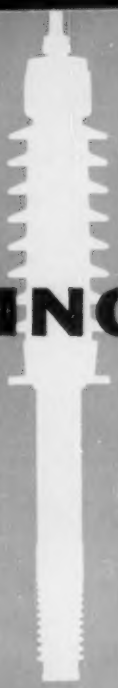
The new silicon is being used to develop still better transistors and rectifiers for telephony. It is another example of how Bell Laboratories metallurgists help open the way to improved telephony.

BELL TELEPHONE LABORATORIES

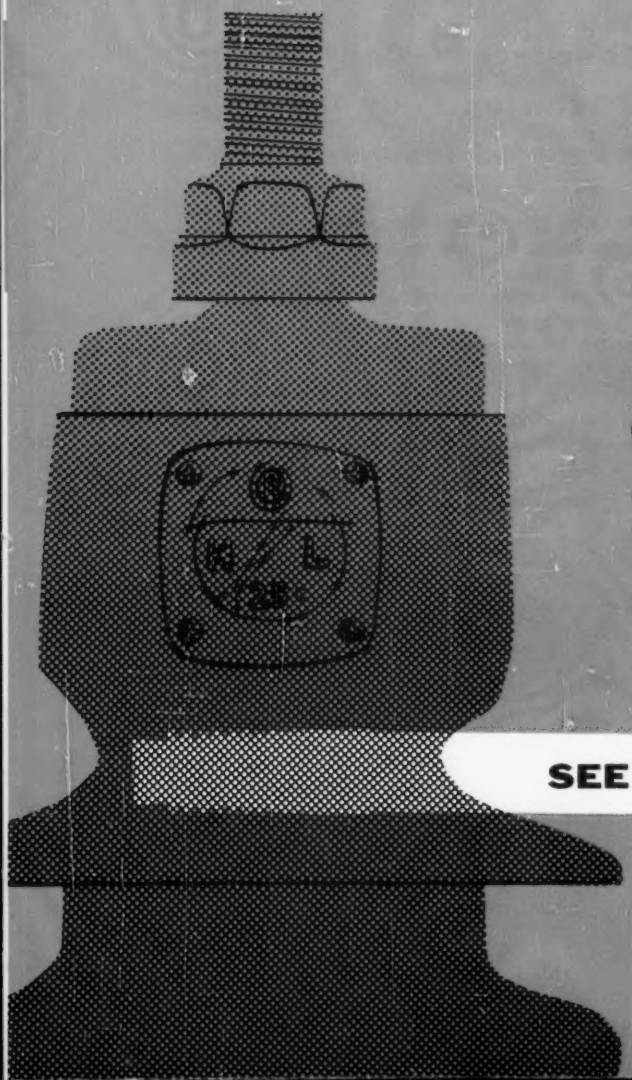
World center of communications research and development



Metallurgist Henry C. Theuerer, M.A. in Chemistry, Columbia, watches a molten zone in a silicon rod under purification. Mr. Theuerer's most recent achievement was development of water-vapor treatment for removal of boron.



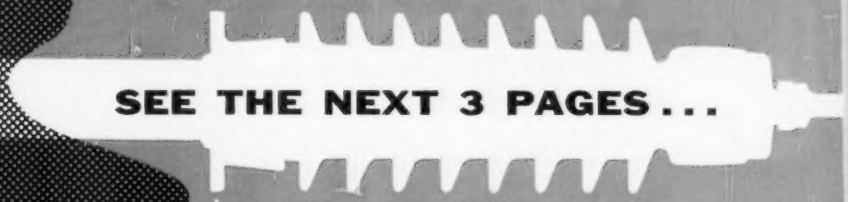
A NEW STANDARD BUSHING NOW COMPLETES THE 69-KV STATION PICTURE



. . . TODAY—YOU HAVE THE CHOICE OF TWO BASIC BUSHING TYPES AND THE WIDEST VARIETY OF LIGHTNING ARRESTERS AVAILABLE FROM O-B—ALL MEETING INDUSTRY STANDARDS — TO FILL EVERY 69-KV REQUIREMENT.

Ohio Brass

MANSFIELD OHIO, U. S. A.



SEE THE NEXT 3 PAGES . . .

now just ask for the 69-kv bushing you want... and you can have

THE BEST OF

from Ohio Brass

New GK-30 Model Announced — Conforming to ASA Standards — Featuring Fully Oil-Surrounded and Oil-Impregnated Insulated Core

"Give us a completely oil-filled bushing for 69 kv, meeting ASA Standards."

This insistent request has been made, repeatedly, by many apparatus users. Bushing builders have tried for it, but it's a big order! An adequate insulating core, space for oil circulation, and an outer porcelain housing—all within the standard restriction of 5¼-inch lower end diameter—has been a difficult challenge.

O-B now announces that this bushing has been devised, thoroughly tested, and is presently in regular production—first in the industry to reach this commercially complete state.

Today, you have free choice of bushing design at 69 kv. There is the LK-30 type using polymerized resin-paper core construction, and the new GK-30 type using oil-impregnated paper, with the core fully oil-immersed. Both types are supplied for either transformers or circuit breakers. Every one meets or exceeds ASA Standards. All are regular production items. All are fully interchangeable.

Ask your apparatus builder for the bushing you want, *and you can have the best of its kind from O-B!*

O-B TYPE GK-30 BUSHINGS ASA-NEMA STANDARD

	CATALOG No.	APPARATUS OIL LEVEL
Draw Lead — 400 Amperes	45413	16½"
	45414	21"
	45415	27"
Fixed Conductor — 1200 Amperes	*45428	16½"
	45429	21"
	45430	27"

* ASA STANDARD CIRCUIT BREAKER BUSHING.

O-B TYPE LK-30 BUSHINGS ASA-NEMA STANDARD

	CATALOG No.	APPARATUS OIL LEVEL
Draw Lead — 400 Amperes	45125	16½"
	45126	21"
	45127	27"
Fixed Conductor — 1200 Amperes	*45152	16½"
	45153	21"
	45154	27"

* ASA STANDARD CIRCUIT BREAKER BUSHING.

ITS KIND

LK-30, ASA Standard Bushing

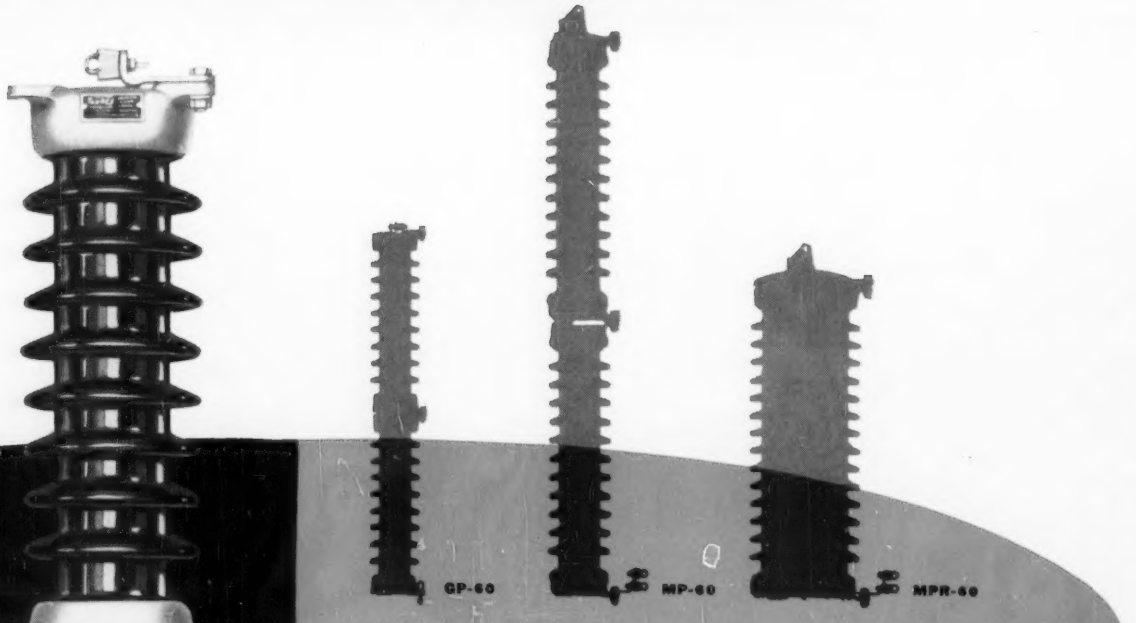
Featuring: (1) Polymerized resin-paper, oil-resistant insulating core. (2) Oil immersion of core only above flange. (3) Exposure of core below apparatus oil level. (4) Multiple varnish coats on exposed core for protection in transit and in service.

GK-30, ASA Standard Bushing

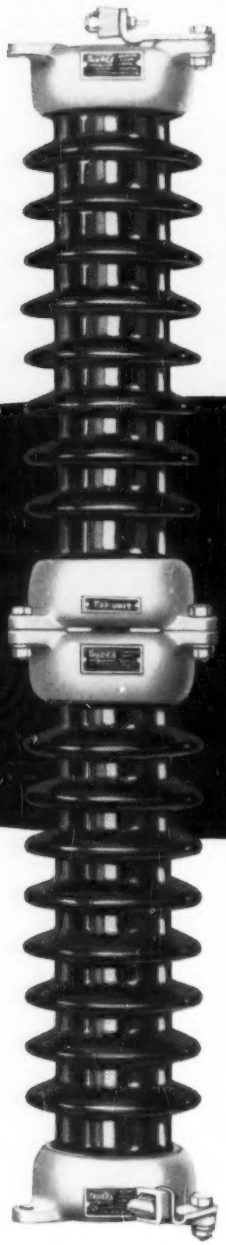
Featuring: (1) Oil-impregnated insulating core. (2) Lower end porcelain housing, providing end-to-end encasement of core. (3) Entire core immersed in circulating oil. (4) Magnetic oil level gauge on expansion reservoir.

Ohio Brass

MANSFIELD OHIO, U. S. A.



TAKE YOUR PICK AT 69 KV



A Complete Line of Thorex Lightning Arresters of this Rating Meets Any Combination of Requirements

Storm frequency, apparatus insulation level, importance of load, budgets—all enter into selection of your lightning arresters. There is an O-B Thorex arrester that will fit.

For the average operating conditions, pick the Thorex GP. It's the lowest-priced of the line, yet it is materially better than any arrester on the American market just five years ago. It is adequate for most jobs.

For more critical protection, or where older apparatus may be involved, there is the Thorex MP with 10 to 15 per cent lower IR discharge rating.

Maximum protective performance and immunity from effects of surface contamination are found in the Thorex MPR.

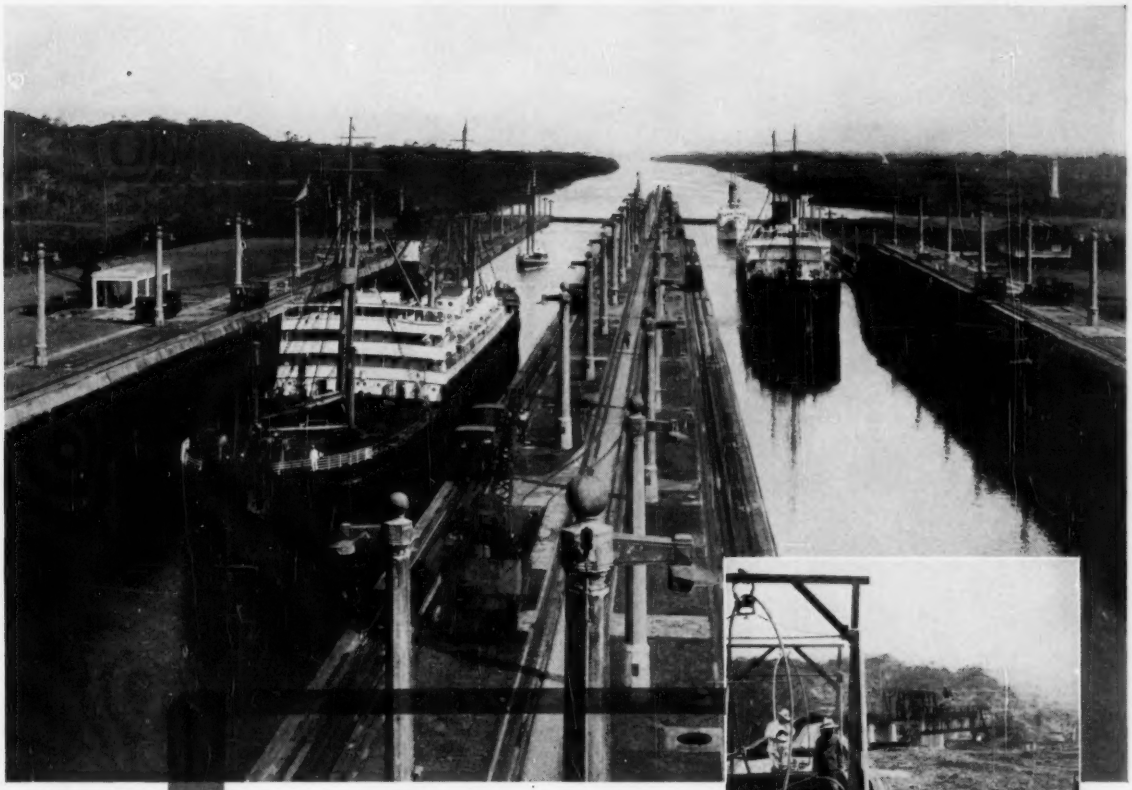
All of these O-B arresters, in 60-kv line-to-ground rating, are applicable to 69-kv systems. All meet or exceed standards for maximum-duty lightning arresters.

You have complete choice for 69-kv station construction among Thorex arresters. And, whatever that choice may be, you will be getting the best and most complete protection per dollar of installed cost. Add "O-B Thorex" to your 69-kv station specifications.

Ohio Brass

MANSFIELD OHIO, U. S. A.

4643-H



The Panama Canal

Laying Kerite Cable across the Isthmus, 1908

Since it was first manufactured almost a century ago, Kerite insulated cable has been closely integrated with the international development of the communications industry. One of the most important installations of Kerite cable was made in 1908 across the Isthmus of Panama, a distance of 50 miles, uniting the Atlantic and Pacific ocean cables.

Early performance records of this outstanding product indicated that Kerite cable was unusually well equipped to withstand the extremely severe conditions attending this tropical installation. This cable, originally laid on the ground in the jungle, was submerged for 30 miles in Gatun Lake upon completion of the canal.

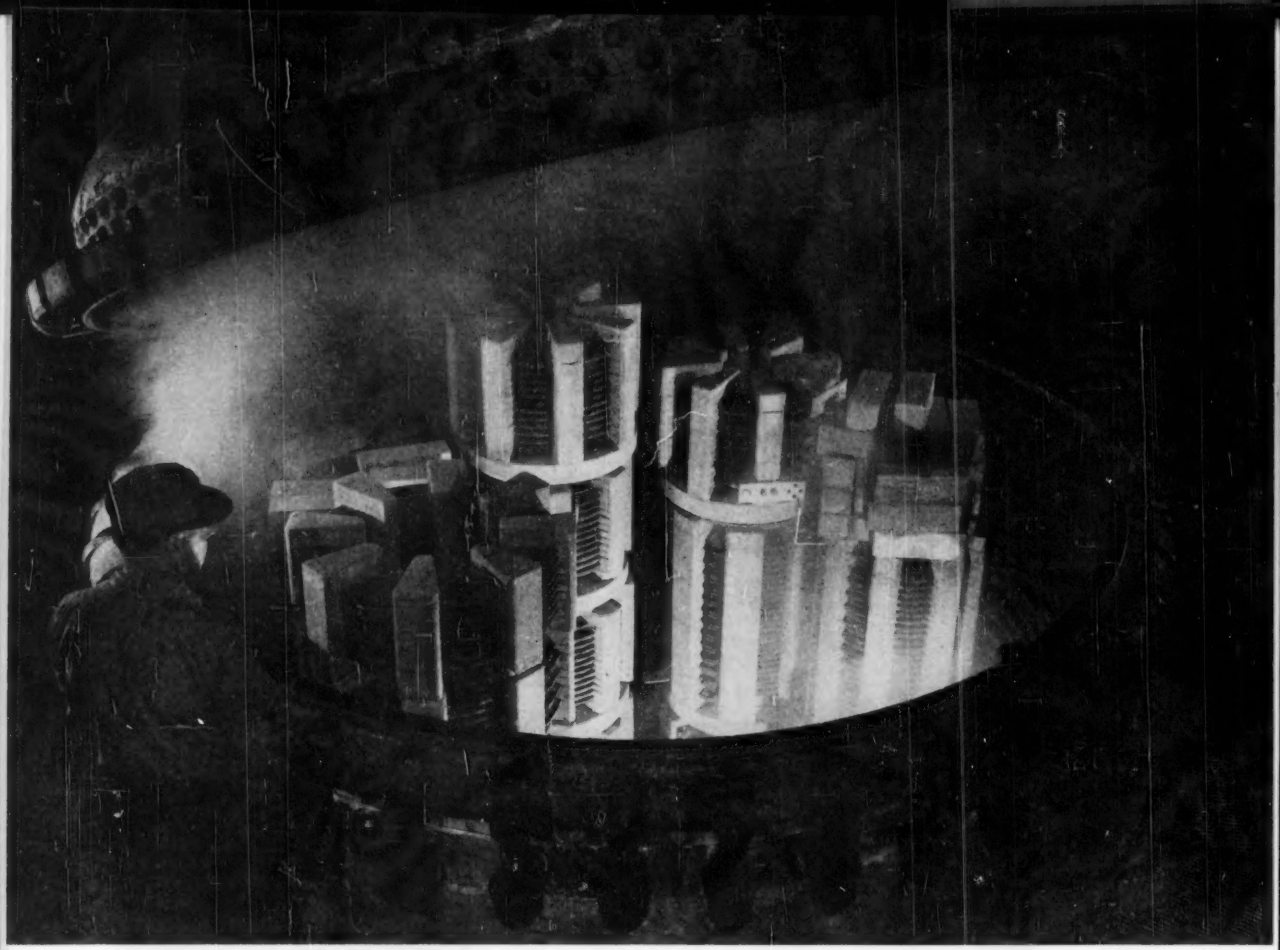
As a result of the operation of this initial cable, a second one was installed in underground ducts in 1918 under the supervision of Mr. C. R. R. Harris, now Chairman of the Board of The Kerite Company. Subject to similar adverse conditions, this cable continues to perform the important function for which it was designated at a critical point in communications history.

The value and service life of a product can be no greater than the integrity and craftsmanship of its maker.

Founded 1854

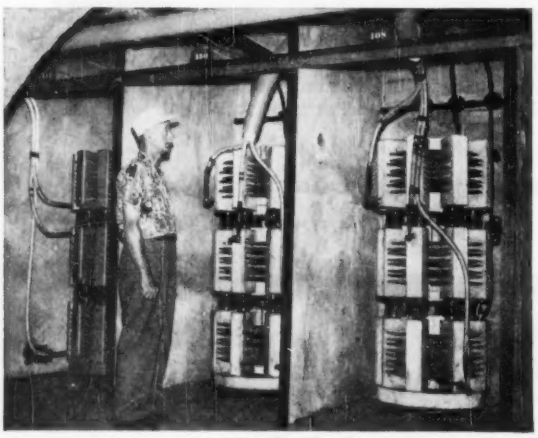
KERITE CABLE

THE KERITE COMPANY—30 Church St., New York 7, N. Y.
Offices also at 122 S. Michigan Ave., Chicago; 582 Market St., San Francisco;
3901 San Fernando Rd., Glendale 4, Calif.; 31 St. James Ave., Boston



PROVEN WET-STEAM CURING PROCESS MAKES

General Electric cast-in-concrete reactors stronger, more reliable



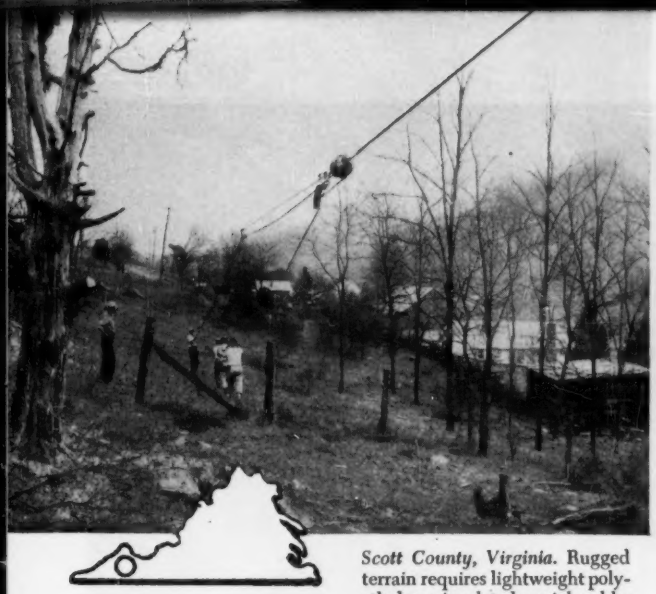
37 YEARS OF SERVICE have been achieved by these G-E cast-in-concrete reactors at Fall River Electric Light Co., Fall River, Mass. Twelve reactors, installed in 1919, are as strong as ever and have required practically no maintenance.

RELIABILITY that begins at the moment of installation and lasts through a longer life is assured to you by General Electric's time-proven methods of manufacturing cast-in-concrete reactors. Using its exclusive wet-steam curing process, G.E. achieves in two days a degree of concrete curing which would be obtained only after several weeks of normal, in-service curing. This unique 180° C steam bath gives you stronger, more reliable reactors than any other curing method in use today.

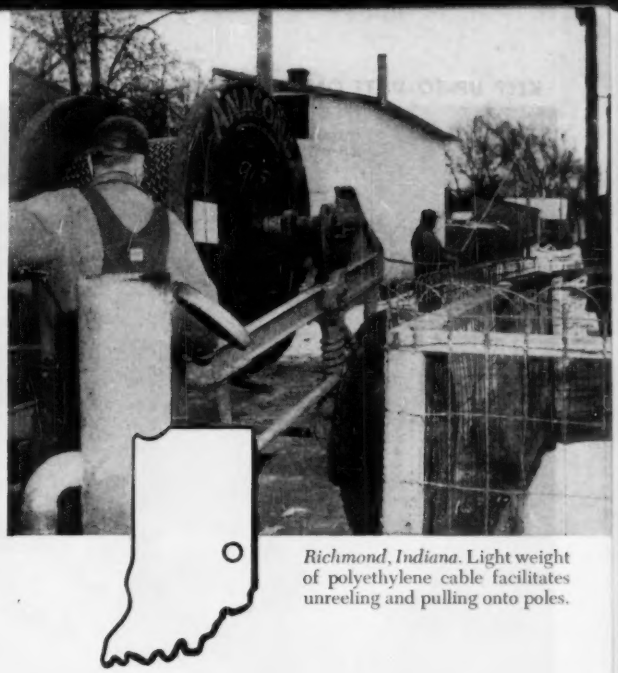
PROOF OF THE STRENGTH of properly cured concrete reactors is demonstrated daily by thousands of G-E reactors in service across the country (see photo left). For other benefits of G-E reactors, contact your local G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, New York. 422-32

Progress Is Our Most Important Product

GENERAL ELECTRIC



Scott County, Virginia. Rugged terrain requires lightweight polyethylene-insulated aerial cable.



Richmond, Indiana. Light weight of polyethylene cable facilitates unreeling and pulling onto poles.

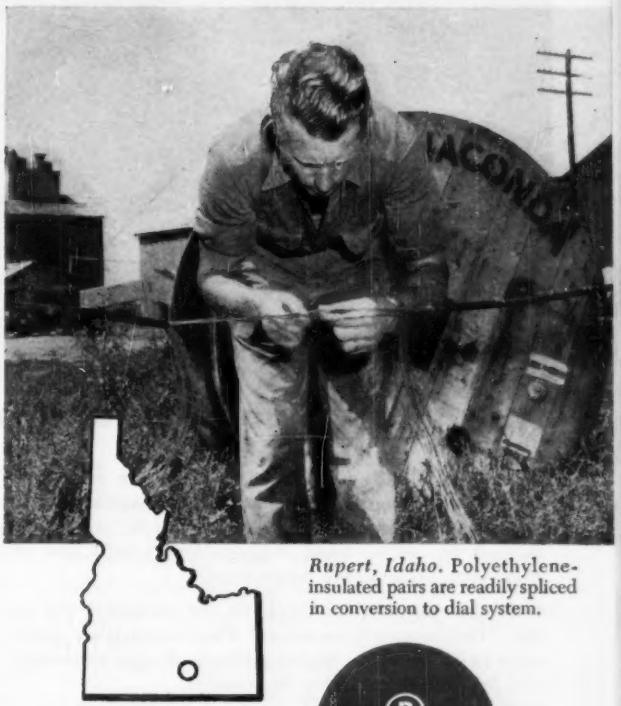
More telephone installations show

why polyethylene is gaining ground

Every user of wire and cable can profit from the years of experience that the telephone industry has now accumulated in the use of BAKELITE Brand Polyethylene. Across the country, exposed to varied climatic conditions and problems of terrain, polyethylene has demonstrated its superiority over older insulating and jacketing materials.

The light weight and toughness of BAKELITE Polyethylene have brought faster, less costly installation with longer spans, fewer poles. Its moisture resistance has drastically reduced weather problems. Its dielectric strength far exceeds telephone requirements.

BAKELITE Polyethylene meets REA requirements for plastic-insulated telephone cable, IPCEA specifications for power cable, ASA standards for weatherproof wire, ASTM D1238-52T Type II dielectric materials, and IMSA specifications for fire alarm and signal control cable. For more information, write Dept. VG-55.



Rupert, Idaho. Polyethylene-insulated pairs are readily spliced in conversion to dial system.

Illustrations show cable produced by Anaconda Wire & Cable Co., New York, N. Y.

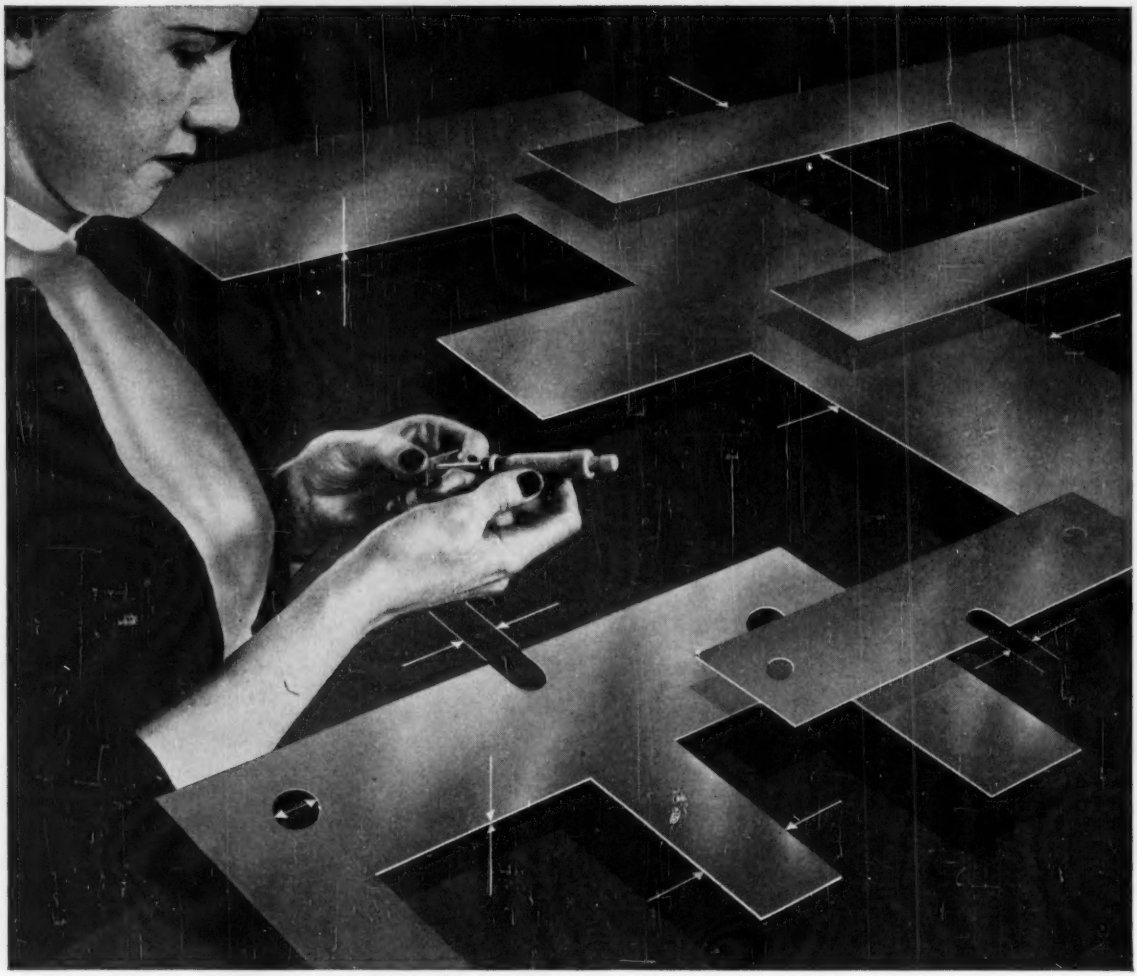
BAKELITE BRAND Polyethylene Plastic

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC.

KEEP UP-TO-DATE ON MAGNETICS



what are the new Performance-Guaranteed laminations?

Whenever our tungsten-carbide dies have produced enough nickel-iron laminations of a new shape to permit stocking them for immediate delivery, we let you know, because we get so many requests for "what's new in *Performance-Guaranteed* laminations?"

It's rather sensible, the emphasis our customers put on this "Performance-Guarantee." They know it's a guarantee based upon our *higher* quality hydrogen annealing, vital for high permeability laminations.

You see, small percentages of impurities, particularly carbon, oxygen and sulphur, have a deleterious effect on magnetic properties—and they are present in every alloy at the beginning despite the most rigid control of the metallurgy of the heats. In this as-rolled state, *the steel will develop as little as 5% of its ultimate permeability.*

Now everyone "hydrogen" anneals—but not everyone *dry-hydrogen* anneals. You can't use bottled hydrogen, without leaving a surface oxide injurious to magnetic properties and making soldering virtually impossible. So we dry our hydrogen to a dewpoint of —60° C, removing the water vapor which is produced by the reduction of hydrogen. Carbon reduces to methane, sulphur to sulphur dioxide, and both are removed by the continuous flow of dry hydrogen during the 24-hour cycle.

As a result of our superior annealing, *we* develop better magnetic properties and clean lamination surfaces, and *you* get that valued "Performance-Guarantee."

New Performance-Guaranteed shapes, in stock, immediately available: EE 28-29, UI-312, F-21, DU-1, DU-37, rotor, stator and head laminations. Why not write today for Catalog ML-201 and full information on these and all other clean, flat, burr-free laminations we manufacture. *Magnetics, Inc., Dept. EN33, Butler, Pennsylvania*

MAGNETICS inc.

CABLE: MAGNETICS

Photo courtesy Public Service Electric and Gas Company of New Jersey

J-M Transite Ducts go in quickly, easily and permanently

Quick, low-cost installation is promoted by Transite Ducts. The light, 10-foot lengths are easily handled . . . and readily joined with either Transite Couplings or J-M Plastic Couplings. Many fittings are available to simplify even the most complicated installation. The permanently smooth interior surface of these asbestos-cement ducts prevents cable injury, makes long pulls possible and simplifies cable replacement.

Incombustible Transite Ducts confine arc damage, protecting adjacent cables from heat and flame. Inorganic, nonmetallic, Transite Ducts are corrosion-resistant, immune to rust and rot and unaffected by electrolysis. These ducts dissipate heat faster, reducing I^2R losses, enable cables to carry heavier loads and prolong insulation life.

Available in 2 types: Transite Conduit for exposed work and installation underground without concrete encasement; and Transite Korduct for installation in concrete.

Let us send you more information about Transite Ducts.
Just write to Johns-Manville, Box 14, New York 16, N. Y.

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Johns-Manville TRANSITE® DUCTS

TRANSITE KORDUCT®—for installation in concrete

TRANSITE CONDUIT—for exposed work and installation underground without a concrete encasement

CURRENT TRENDS

No. 7 in a series of articles

Cable Identification?

Nearly all electrical cables must carry identification for such various reasons as to establish identity of manufacturer, age, circuit choice and temperature rating. Of these, the important identity to most users is to readily permit proper circuit or phase selection as well as source of manufacture. The methods employed to gain these objectives must result in quick and clear intelligible information conveyed in a medium which is reasonably permanent and economical to achieve.

Circuit Identification

The subject of circuit identification in cables is somewhat complex. Its purpose is obvious—to identify a particular circuit, phase, polarity or other end use towards easier installation and maintenance. The most conservative approach eliminates all requirements for circuit identity within the cable so that each and every circuit must be electrically "rung out" or checked by the installer. However, the most popular approach requires some particular form of identity, of which there are many. Industry standards for a particular type of circuit identity have been established by many groups including IPCEA, NEMA, NEC, ASA, IMSA, Underwriters' Laboratories, and many others.

Insofar as control cable is concerned the original NEMA color sequence arrangement has become so well established that any newer methods simply represent an alternate interpretation of the original system as outlined in IPCEA Table XXX. This provides for 127 different color combinations by the employment of solid base colors and either one or two stripes or tracers of a contrasting color. This procedure as originally established was intended for fabric braid coverings where it was a simple matter to insert colored tracer threads in one or more carriers of the woven braid. To apply the identical procedure to modern jacket coverings over the insulated conductors such as Neoprene and polyvinyl chloride where braids are not employed presents certain problems. Hence, the development of a new identification method (IPCEA Method 3) now used by the Rome Cable Corporation for these types of multiconductor control cables where a contrasting, permanent surface printing is applied over a single black or neutral base color. The first six primary colors are printed 1-black, 2-white, 3-red, 4-green, 5-orange, 6-blue. For more than six conductors the tracer color is printed directly following the base color such as 7-white-black, 8-red-black, etc. To be readily distinguishable the printing appears on opposite sides of each conductor at regular frequent intervals. This low-cost method is strongly recommended for these types of cables since it expedites production, eliminates problems of color matching and fading, eliminates errors due to color blindness which is fairly prevalent, and provides a positive method of identification for the life of the cable. Other identification possibilities involving colored spirally or longitudinally applied stripes over colored jackets are also used and are described in IPCEA Methods 1 and 2.

Power cable identification is simplified since here we are only concerned with a maximum of three or possibly four phase identities which may be accomplished in a number of ways. On unshielded non-metallic sheathed cables a preferred system utilizes permanently molded longitudinal ribs on the sheath surface. The same procedure may well be used on shielded cables although appropriately printed semiconducting tapes under the metallic shielding tape has been generally accepted. On lead sheathed cables a colored tape directly under the lead sheath accomplishes the job. On certain multiconductor signal, telephone, telemetering, instrumentation and communication cables a simple method of circuit identification is frequently employed which consists of one colored conductor or pair in each layer of the multi-layer assembly of conductors. This colored circuit serves as a reference point from which the remaining circuits may be located by counting in a given direction in each layer.

Manufacturer and Miscellaneous Identification

A relatively simple time-proven system is used by most cable manufacturers to identify their product as an aid in reordering or replacing cable. Manufacturers of Underwriters' labeled products such as building wires and cords are assigned specific colored marker threads to be incorporated in their products and most manufacturers usually extend the use of these same colored threads in other cable products where practicable. This identification consists of colored combinations of small threads. For example, Rome Cable Corporation uses one yellow and one blue thread. These threads may be incorporated in appropriate locations within the cable design, such as in or over the stranded conductor, in the interstices of a multi-conductor assembly or under the outer sheath. Other methods of manufacturer identity are frequently used such as stamping on solid conductors, printed marker tapes, or surface printing in some acceptable manner such as the permanently molded name used on all Rome-60 portable cables. In some cases even the customer name and other information may be included where practicable and added cost is not prohibitive.

A printed marker tape incorporated within the cable assembly is the easiest approach to this situation which may be further embellished with unit length markings as well as date of manufacture. A rather novel method to accomplish this was developed by Rome Cable engineers (U.S. Patent 2,705,-735) which comprises recording on a magnetizable wire a record of information relating to the cable and combining this wire in a suitable location within the cable construction.

The foregoing represents only a condensed review of the highlights on this little publicized subject. Most problems, of which there are many, can be solved by following appropriate standards and some of the ideas mentioned above. Here again, Rome Cable's experience might be of real value to you, so why not discuss your particular cable identification problem with us?

ROME CABLE CORPORATION, Rome, New York

SILICON?

GERMANIUM?

SELENIUM?

INTERNATIONAL'S Application Advisory Department can solve this problem for your application!

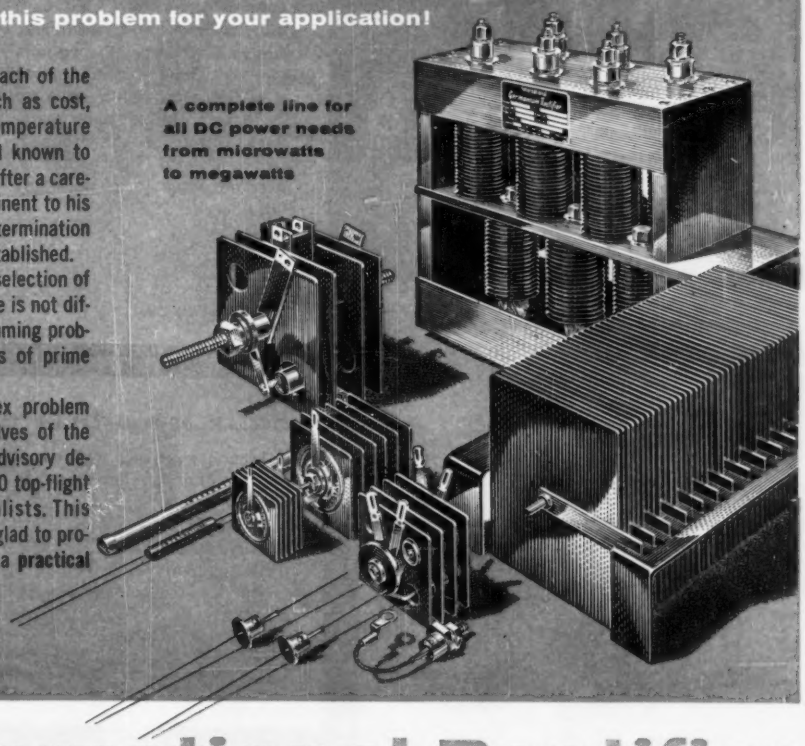
The distinct advantages of each of the semi-conductor materials, such as cost, efficiency, size, operating temperature range, and reliability, are well known to the design engineer. It is only after a careful analysis of the factors pertinent to his application that a concise determination of the prime factors can be established.

In a simple application, the selection of the **right** semi-conductor device is not difficult. It becomes a time-consuming problem with certain combinations of prime requirements.

If you have such a complex problem we invite you to avail yourselves of the services of our application advisory department, comprised of over 50 top-flight rectifier engineering specialists. This department will be more than glad to provide a prompt evaluation and a **practical** recommendation.

Just write, telephone or wire.

A complete line for all DC power needs from microwatts to megawatts



A WORLD OF DIFFERENCE THROUGH RESEARCH

International Rectifier

CORPORATION

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THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

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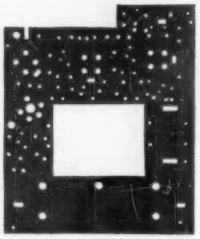
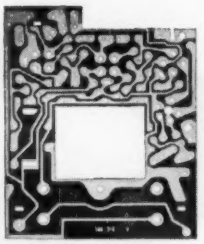


As manufactured by
INSULATED CIRCUITS, INC., WEST CALDWELL, N. J.

Your printed circuitry is off to a good start when you specify one of C-D-F's Metal-Clad Dilecto grades. Base materials are uniform, almost homogeneous—therefore easier to punch, drill, form...with less waste of expensive time and materials.

EASY TO ETCH!

The closely bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. HIGH BOND STRENGTH is an all-important virtue of C-D-F Metal-Clads.



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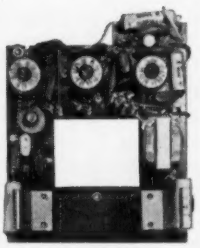
FOUR FEATURES YOU GET WITH C-D-F METAL-CLAD LAMINATES

EASY TO ASSEMBLE!

Automatic or hand assembly is speeded when printed circuits are on dimensionally stable C-D-F Dilecto. Minimum warp and twist. Unlike many materials, Dilecto can be dropped, jammed into tight chassis, treated roughly in assembly and service.



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EASY TO SELL!

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Regency Division, I.D.E.A., Inc.
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Manufacturers, like I.D.E.A., Inc., whose Regency transistor radio is pictured, find C-D-F a big, reliable source of supply. C-D-F delivers high-quality laminates on time, to meet exacting production schedules. Result: better products, made and sold at lower costs!

C-D-F Metal-Clad Dilecto

A laminated plastic with copper or aluminum sheet bonded tightly to one or both surfaces. Base materials: paper or woven glass fabric. Resins: phenolic, epoxy, or Teflon*. Good deliveries; expert engineering and fabricating service.

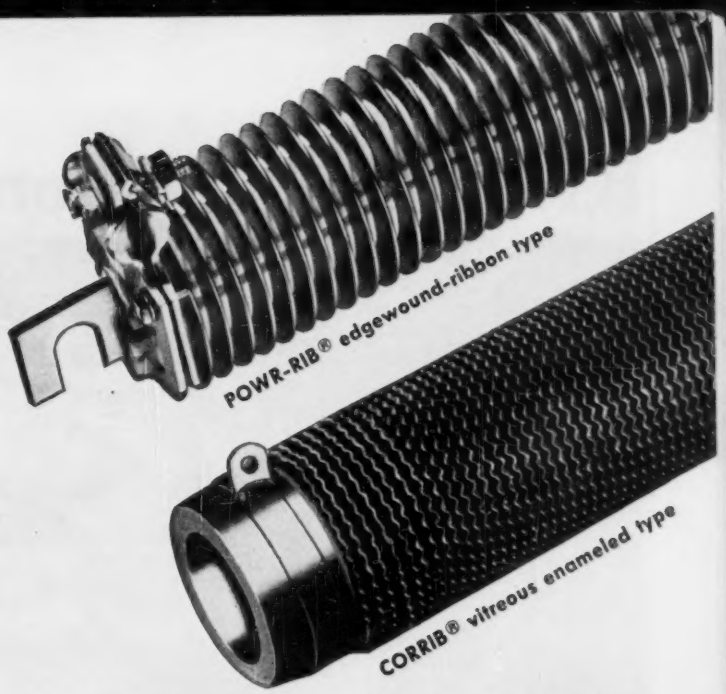
Write for *new* Metal-Clad Technical Bulletin, samples of all grades. The name and address of C-D-F sales engineer nearest you are listed in both Electronics Buyers Guide and Product Design File (Sweet's). *DUPONT TRADEMARK

improves design . . . simplifies purchasing . . . speeds production!

CONTINENTAL DIAMOND FIBRE

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
NEWARK 86, DELAWARE

specify OHMITE® *Power Type* **RESISTORS** for high current low resistance applications—



The Ohmite line of specialized CORRIB and POWR-RIB resistors solves your high-current, low-resistance problems. The four basic types of Ohmite units (shown below) handle a wide range of special power resistor needs. They are designed for continuous or intermittent duty and provide dependability for heavy-duty applications. Available in Fixed or Adjustable "DIVIDOHM®" Types.

IN STOCK—22 Corrib Resistance Values in 300 Watt Size (Core 8½" x 1⅛").

IN STOCK—26 Powr-Rib Resistance Values in 5 Section Size (17⅞" long).

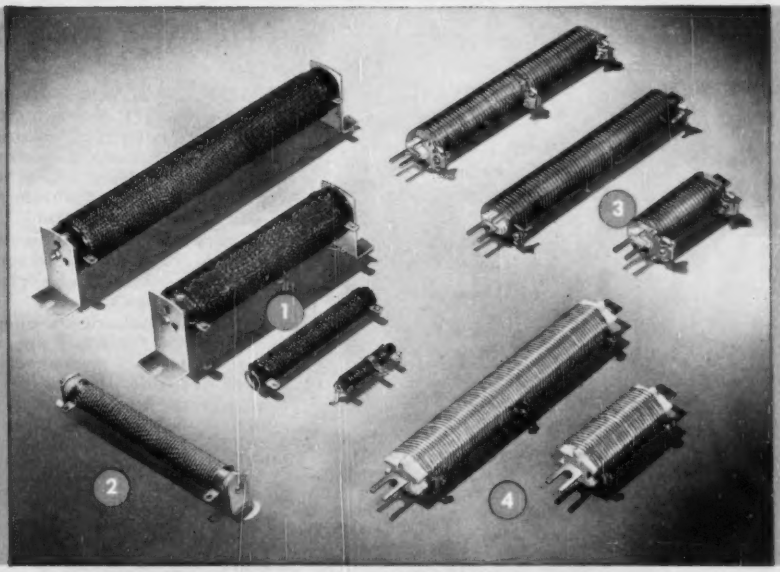
Write for Bulletin 144

1 CORRIB®
vitreous-enameled corrugated-ribbon type
Fixed, tapped, and adjustable types in 25 sizes, 90 to 1500 watts. Resistances from .04 to 110 ohms.

2 CORRIB®
bare threaded tube type
For continuous or intermittent operation at higher than normal 375°C temperature rise. In two sizes, from 0.36 to 4.25 ohms.

3 POWR-RIB®
edgewound-ribbon type
Has ceramic core, sectionalized to resist shock. Four sizes. Values .043 to 1.6 ohms; 24 to 95 amps.

4 POWR-RIB®
round-wire type
Has sectionalized core similar to ribbon type. Four sizes. Values from .69 to 25 ohms; 5.1 to 18.4 amps.



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RHEOSTATS
RESISTORS
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TANTALUM CAPACITORS

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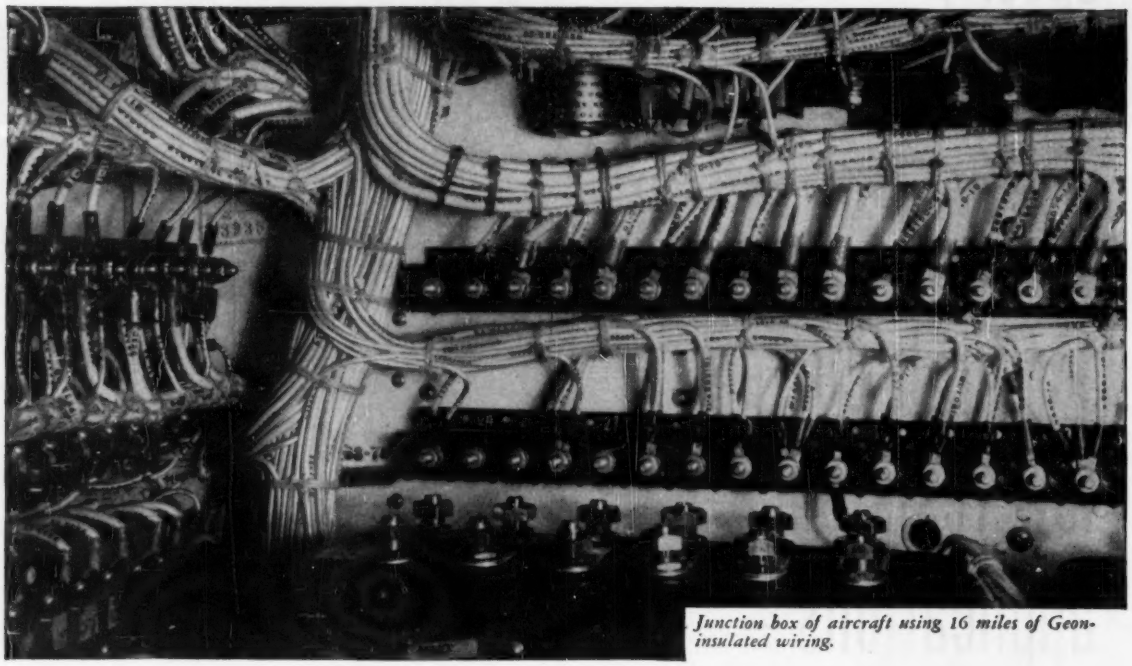
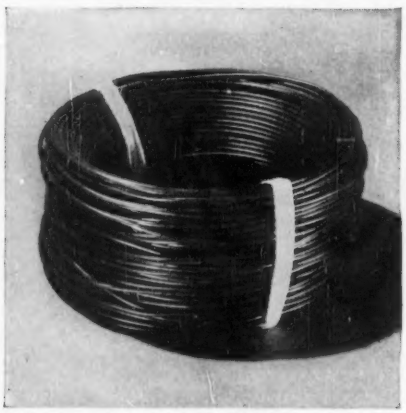


Junction box of aircraft using 16 miles of Geon-insulated wiring.

For wiring that shrugs off water, chemicals, flame...



You can select wire and cable with Geon used either as primary insulation, or jacketing, or both. Many compounds available to meet specific requirements.

specify Geon insulation

GEON-INSULATED wire and cable provides *power dependability* despite tough operating conditions.

Take water. Geon insulation tested by continuous immersion in water for three years showed no appreciable change in its excellent electrical properties. Geon has superior resistance to oils, resists most acids at all concentrations under many conditions. Geon compounds are flame resistant.

In physical properties Geon is likewise outstanding. Compounds aged outdoors for up to fifteen years have retained original properties. Geon is tough and abrasion resistant, keeps flexibility at very low temperatures.

Leading manufacturers offer Geon-insulated wire and cable for automotive and aircraft use, electrical equipment, machine tools, signal systems . . . wherever power dependability is important. For booklet giving complete data on Geon insulation properties, write Dept. DH-6, B. F. Goodrich Chemical Company, 3135 Euclid Ave., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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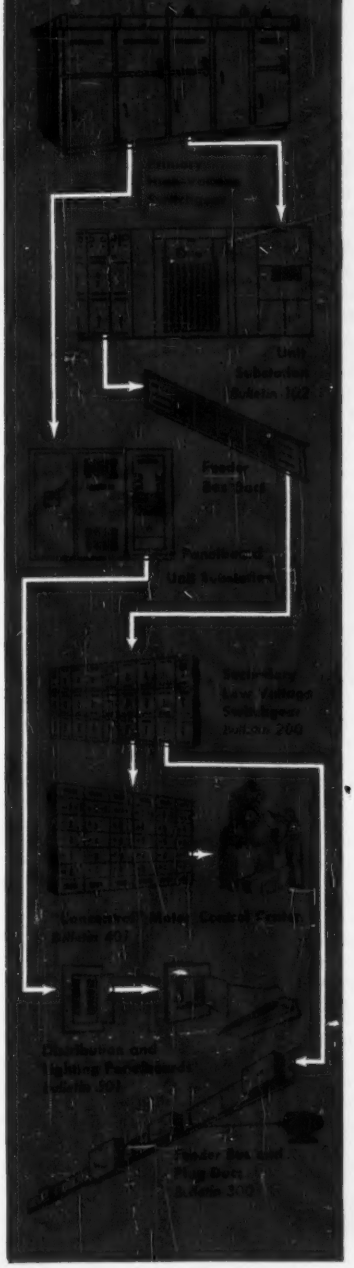
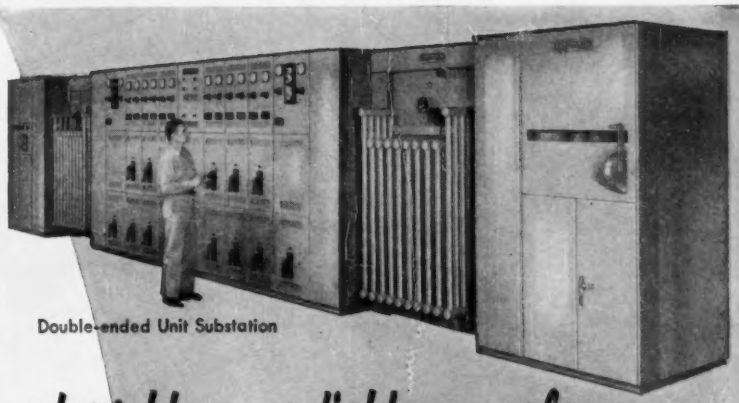
PATH of POWER through CONTINENTAL EQUIPMENT





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adaptable . . . reliable . . . safe . . .

UNIT SUBSTATIONS

Unit Substation with Dry Type Transformer

Panelboard Unit Substation

Assure Production Continuity at the Most Economical Power Cost

CONTINENTAL Unit Substations incorporate equipment protection based on system requirements. Engineered as self-contained power centers, they offer guaranteed quality and craftsmanship. Production goes up . . . maintenance worries and power costs come down! Delivered complete, they can be readily expanded or relocated for maximum efficiency.

- broad selection of primary equipment to fit installation requirements
- 4 standard types of transformers
  - self-cooled dry type
  - sealed dry type
  - non-inflammable liquid type
  - oil filled type
- complete choice of secondary equipment to suit operational demands

SHIPMENT: 8 WEEKS*

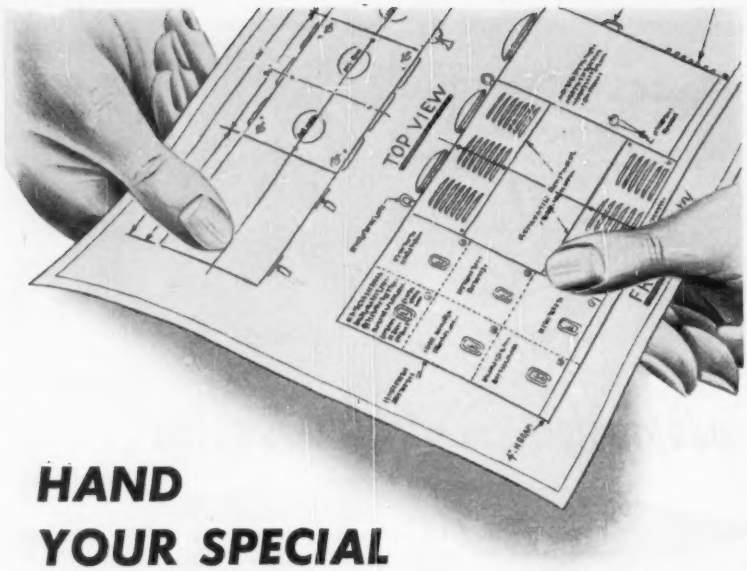
Compare for yourself. Write for detailed specifications today.

CONTINENTAL ELECTRIC EQUIPMENT CO.

General Offices: 203 West 4th St., Cincinnati 2, Ohio

Manufacturing Plants in Ludlow, Ky. and Tampa, Fla. Sales Engineering Offices in all Principal Cities

*BASED ON RECEIPT OF COMPLETE REQUIREMENTS. IF APPROVAL DRAWINGS ARE REQUIRED, ADD 2 WEEKS



HAND YOUR SPECIAL TRANSFORMER PROBLEMS TO...

Standard
TRADE MARK

YOU CAN SAVE many valuable man-hours and production hours by placing your special transformer problems in the capable hands of experienced STANDARD TRANSFORMER engineers. STANDARD engineers can easily detail all of your transformer requirements and oversee their manufacture from beginning to end. There's a STANDARD representative near you. Call him today!

300 KVA indoor unit sub-station or load center, consisting of high voltaged, fused air brake switch and low voltage section with circuit breakers and transformer.

Standard®
THE STANDARD TRANSFORMER COMPANY
WARREN, OHIO
REPRESENTATIVES IN PRINCIPAL CITIES

Trade Literature

(*Continued from page 44A*)

Price and Data Selector. Offered to rural transformer users is a convenient slide rule price and data selecter by the Pennsylvania Transformers Company. The pocket-sized selector covers the company's entire line of Pole Star rural transformers, which range in size from 3 through 25 kva. Included are list prices, electrical data, and mechanical dimensions for all voltage classes, and for various types of transformers. The Pole Star rural transformer price and data selector may be obtained free of charge by writing to Distribution Sales Department, Pennsylvania Transformer Company, Box 330, Canonsburg, Pa.

Corrosion Protection. Techniques for protecting underground pipe from corrosion with Scotchrap brand pipe insulation tape is the subject of a new how-to-do-it booklet announced by Minnesota Mining and Manufacturing Company, Department D6-262, 900 Fauquier St., St. Paul, Minn. Called "Tape It Easy," the new 24-page booklet provides step-by-step photographs and instructions for wrapping bends, elbows, and short sections; patching pipe with tape; preparing joint surfaces for wrapping; wrapping welded joints and taping straight pipe sections as well as "T" fixtures and other typical fittings. An additional section contains a summary of helpful suggestions for making pipe protection with tape easy. A coverage table on the book's back cover lists recommended tape width for various pipe sizes, outlining the minimum recommended tape overlap and the number of squares of tape needed per 100 feet of pipe using various overlaps. The booklet may be obtained by writing to the manufacturer at the aforementioned address.

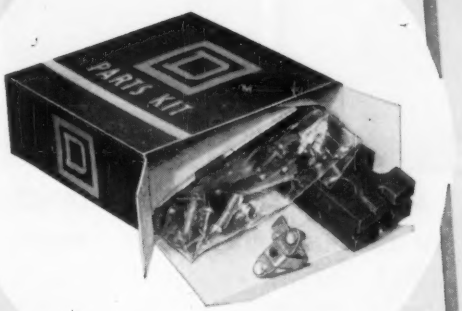
Forging Booklet. Design, properties, and applications of brass, bronze, and aluminum hot-pressed forgings are treated in a new 32-page booklet released by Titan Metal Manufacturing Company, Bellefonte, Pa. Featured in the new publication is a 6-page discussion of design factors involved in specifying and producing forgings. Factors of strength, core size, flash line, projections, staggered lines, fillets, lettering, dimensional tolerances, and other problems are treated with text and photos in this section. In addition, the booklet presents detailed material on advantages of using brass or aluminum forgings, available alloys with their properties, how forgings are made, a commercial dimensional tolerance table, machining advantages, a complete list of forging terms, and important data necessary when ordering forgings. Photographs of many forgings of common as well as unusual shape are shown. The booklet is available free by writing on company letterhead to: Department U-42, Customer Service Division, Titan Metal Manufacturing Company, Bellefonte, Pa.

(*Continued on page 76A*)

Here's Why We Specify
SQUARE D Starters
on the Machinery We Buy

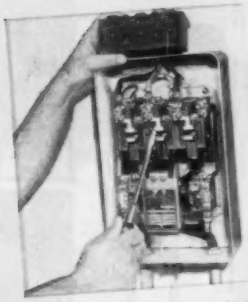
PERFORMANCE, EASY INSPECTION AND MAINTENANCE

Sure, we like Square D performance because it keeps our "down time" at a minimum. BUT—everybody knows that even the best starter needs periodic inspection and preventive maintenance. We like the way Square D makes it easy to handle those routine jobs.

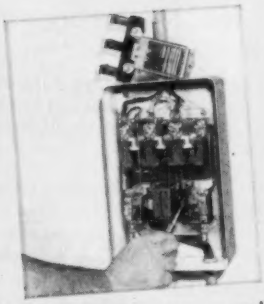


OFF-THE-SHELF PARTS KITS

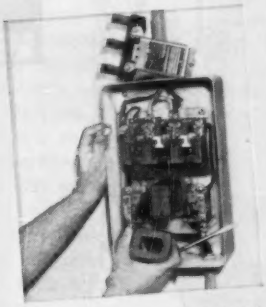
They make normal maintenance and modifications easier than ever. Packaged parts include interlocks, contacts, coils, overload relays, pushbuttons and selector switches. They're easy to buy, easy to identify, and faster to install.



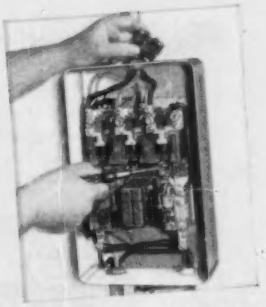
1 Loosen two screws and the arc chamber cover comes off. Every contact surface can be inspected at a glance.



2 Remove four screws and entire movable assembly can be lifted off. Disconnect two wires and slip off magnet coil.



3 Contacts are attached with separate screws—they can be removed and replaced without disturbing any wiring. A screwdriver is the only tool needed.



4 Sizes 0 through 4 starters have these separate mounting electrical interlocks for easier installation. Contact block is attached from front of panel with two screws.

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

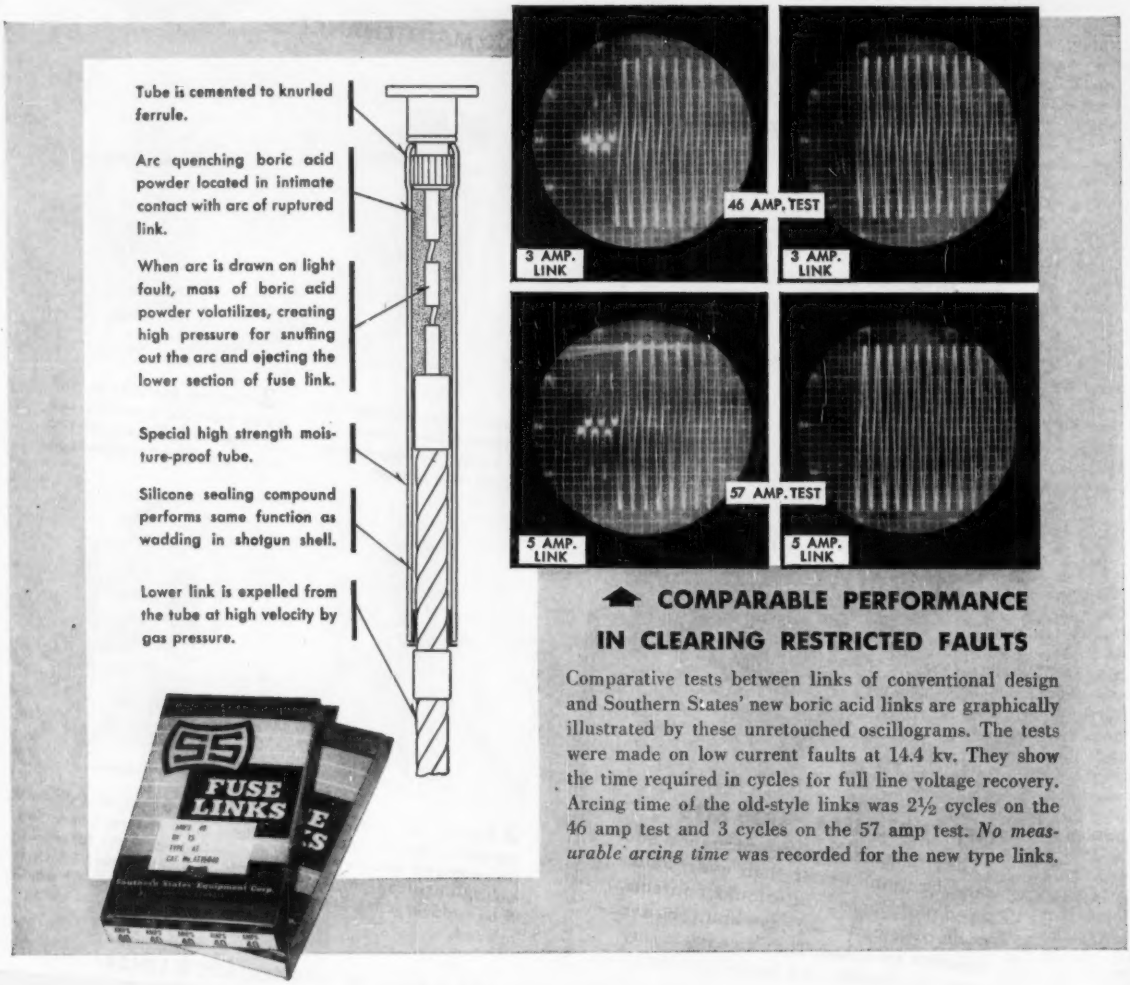
SOUTHERN STATES FUSE LINKS SOLVE PROBLEM OF LOW FAULTS

The problem of clearing restricted faults can be effectively eliminated by using Southern States boric acid fuse links. Even when using large bore cutouts, a low-magnitude fault can be cleared with little arcing.

As the illustration below shows, boric acid powder is in intimate contact with the fusible element. When the link ruptures, the mass of boric acid volatilizes, building a vapor pressure high enough to quench the arc instantly.

The added protection afforded by boric acid links virtually eliminates the possibility of cutout failure when called on to operate in the low current range.

Standard construction features of these links include: silver plating of all external metal parts . . . high-strength crimped joints . . . low-melting temperature elements . . . and moisture-resistant auxiliary tubes. You get a stronger link, more resistant to corrosion, and more dependable than ever.

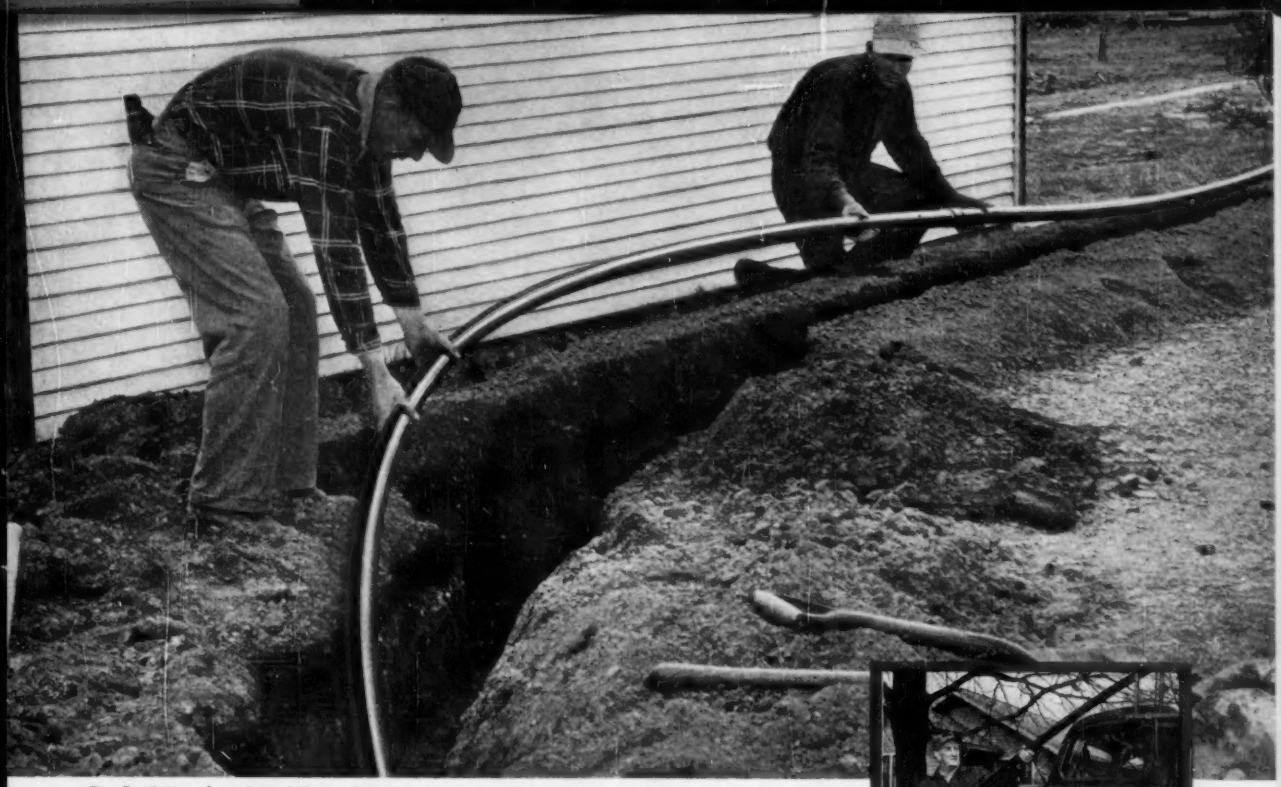

Tube is cemented to knurled ferrule.
Arc quenching boric acid powder located in intimate contact with arc of ruptured link.
When arc is drawn on light fault, mass of boric acid powder volatilizes, creating high pressure for snuffing out the arc and ejecting the lower section of fuse link.
Special high strength moisture-proof tube.
Silicone sealing compound performs same function as wadding in shotgun shell.
Lower link is expelled from the tube at high velocity by gas pressure.
FUSE LINKS WITH FIBER AUXILIARY TUBE
FUSE LINKS WITH BORIC ACID POWDER
46 AMP. TEST
3 AMP. LINK
3 AMP. LINK
57 AMP. TEST
5 AMP. LINK
5 AMP. LINK
FUSE LINKS

COMPARABLE PERFORMANCE IN CLEARING RESTRICTED FAULTS

Comparative tests between links of conventional design and Southern States' new boric acid links are graphically illustrated by these unretouched oscillograms. The tests were made on low current faults at 14.4 kv. They show the time required in cycles for full line voltage recovery. Arcing time of the old-style links was 2½ cycles on the 46 amp test and 3 cycles on the 57 amp test. *No measurable arcing time* was recorded for the new type links.

SOUTHERN STATES EQUIPMENT CORP.
HAMPTON, GEORGIA

IN CANADA: Dominion Cutout Co., Ltd., Toronto



The flexibility of conduit of Tenite Butyrate permits it to be curved in installation, eliminating the need for many ell fittings.

Brookville Telephone Company selects plastic conduit of Tenite Butyrate for its flexibility and smooth walls

The Brookville Telephone Company, Brookville, Indiana, had to install approximately 280 feet of cable conduit between two poles, in a location which would ordinarily have required the use of many right angle fittings. Seeking an easier and faster method, the company selected conduit of Tenite Butyrate, extruded by Yardley Plastics Co., Columbus, Ohio. This Eastman plastic has the flexibility to curve around most corners and obstacles, and presents the smooth inside walls necessary for fast, easy cable pull-through.

In making the installation, a two-foot deep ditch was first opened. Then, lengths of conduit of Tenite Butyrate were joined, using slip-sleeve couplings and solvent cement. As each section was added, a drag was inserted. The assembled conduit was next dropped into the trench, and the cable pulled through. Backfilling completed the installation. The entire job was finished in a fraction of the time usually required with metal conduit.

Conduit of Tenite Butyrate has other advantages, too. It's amazingly light in weight (one man can easily handle three 20-foot sections of 4" diameter), yet has high impact strength. It can be cut with a hand saw, and requires no threading. And it is unaffected by corrosion or electrolytic action of soil.

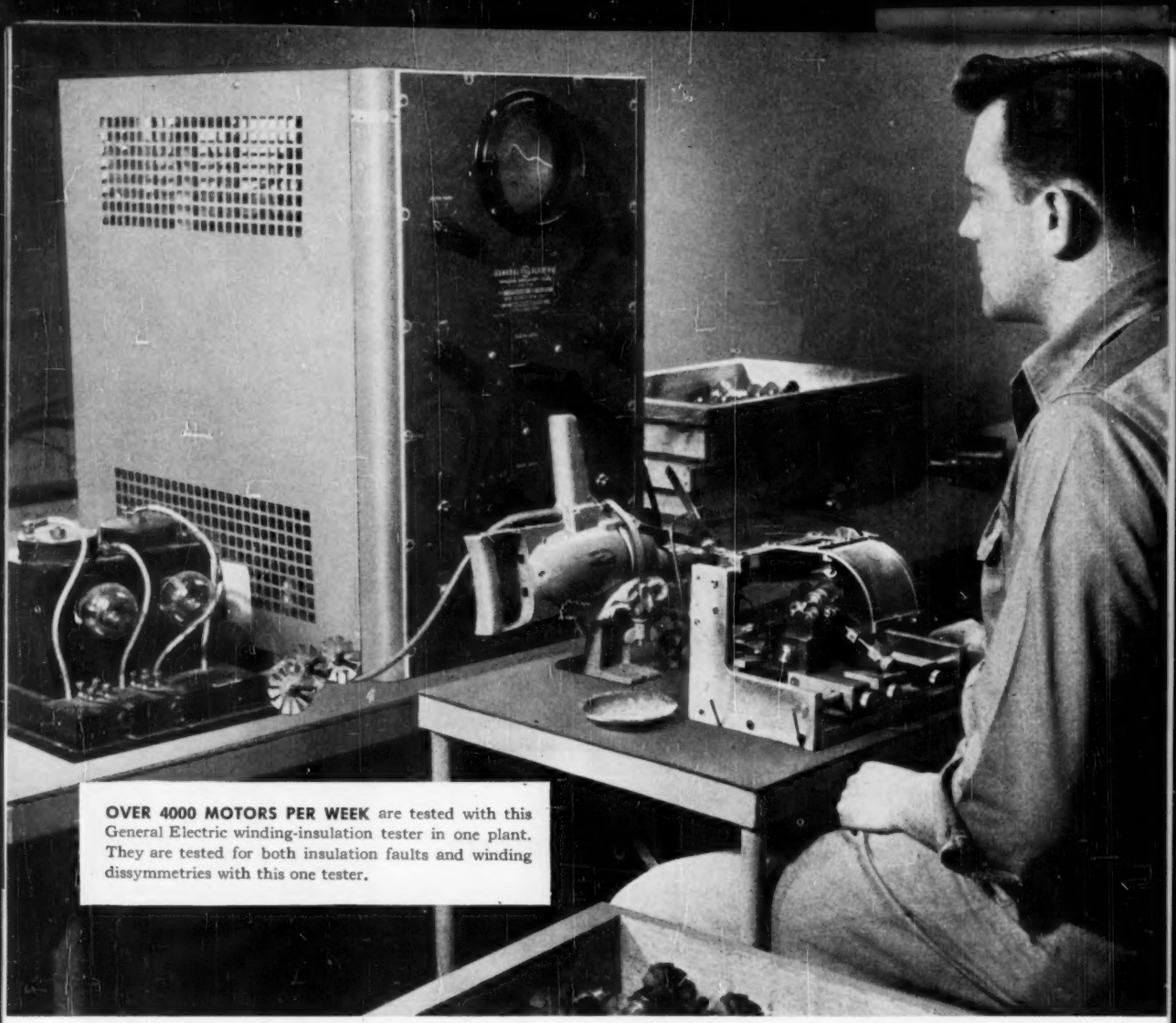
These are just some of the reasons why conduit of Tenite Butyrate is proving so successful in carrying both telephone and electric cables. For a booklet giving more information and a list of manufacturers supplying pipe and fittings made from this versatile Eastman plastic, write: EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE
BUTYRATE
an Eastman plastic

The light weight of Tenite Butyrate conduit makes it easy to handle.

Slip-sleeve couplings and solvent cement are used to connect lengths of Butyrate conduit. No need for threading.

Drags and cable slide through easily, thanks to the smooth walls of Tenite Butyrate conduit.



OVER 4000 MOTORS PER WEEK are tested with this General Electric winding-insulation tester in one plant. They are tested for both insulation faults and winding dissymmetries with this one tester.

Cut Costs With Faster General Electric Winding-Insulation Tester

Decreased testing time and reduced customer complaints are made possible with the General Electric winding-insulation tester because it accomplishes in one short test the same objectives as resistance and impedance balance measurements, high-frequency and high-potential tests.

IT TESTS SIMULTANEOUSLY for winding dissymmetries such as a ground, shorted turns, incorrect connections or the wrong number of turns. The balance-and-comparison method of testing is used to check the insulation of coil windings with repeated surge voltages similar to stresses caused by lightning, switching or other power-circuit transients which are frequent causes of motor failure. It tests for faults in motors, generators, transformers, ballasts, relays and other equipment windings. Tests can be taken at surge peak voltages up to 10,000 volts.

SIMPLE OPERATION of the G-E winding-insulation tester makes production testing easy. The tester is built into a steel cabinet for bench mounting and all controls are conveniently located. Several coils a minute can be tested under production conditions. This fast and highly reliable testing procedure saves valuable man-hours and helps assure higher quality products. Priced at $2910.60* the General Electric winding-insulation tester will quickly pay for itself from savings realized by its use.

For further information call your General Electric Apparatus Sales Office or write to Section 585-58, General Electric Company, Schenectady 5, New York.

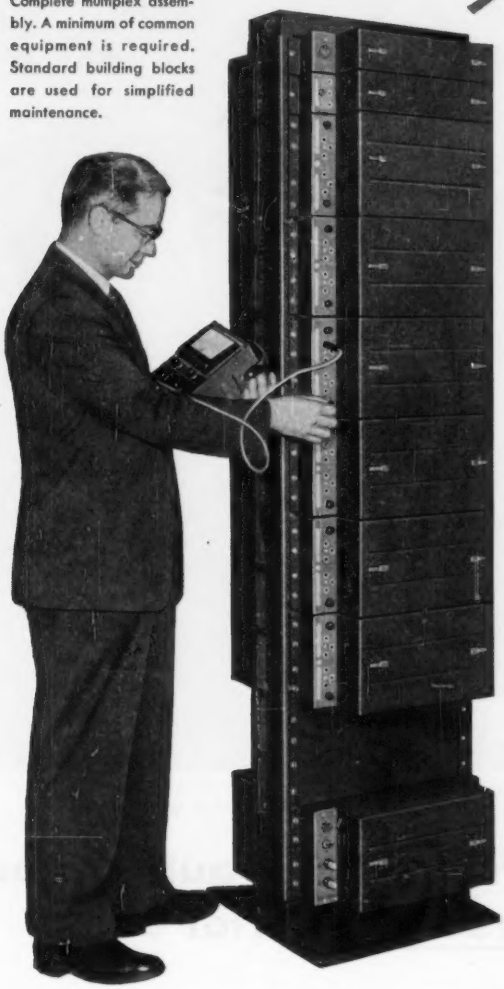
**Manufacturer's suggested resale price.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

NOW... Big News in Microwave Multiplex Channeling Equipment!

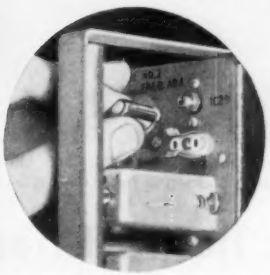
Complete multiplex assembly. A minimum of common equipment is required. Standard building blocks are used for simplified maintenance.



New RCA Type MV-124 with All Channel Units Identical and Interchangeable

Specifically designed for microwave use and thoroughly field tested, this new RCA Channeling Equipment provides complete flexibility. Frequency selection is by means of a plug-in crystal. Except for this crystal, *all Channel Units are identical and interchangeable*, thus simplifying planning, installation and maintenance.

Whatever your channeling requirements, these famous quality Channel Units can be easily stacked to provide two channels, three channels, or up to 24 voice channels without group modulating. High capacity systems can be obtained by stacking 24 channel groups. One unit is required for each voice channel desired. Single sideband suppressed carrier techniques are used to supply 24 channels in the band between 10 kc and 130 kc frequency, leaving frequency space for 18 tone channels below 10 kc. Simultaneous transmission of many channels of intelligence is accomplished by modulating separate sub-carriers spaced uniformly throughout the base-band modulating system. Channels are spaced one above the other in the available modulating band width.



To change channel assignment, simply change one plug-in crystal.

CRYSTAL CONTROL assures high stability and greater accuracy. For operations such as frequency shift telegraph and facsimile transmissions, an unusually high degree of clarity is attained.

DOUBLE HETERODYNING enables all circuits in all units to be identical except for the plug-in crystal element.

SINGLE SIDEBAND OPERATION enables each channel to use a minimum of spectrum space. This means less obsolescence due to possible congestion of the available microwave spectrum.

RCA Microwave . . . performance-proved in more than a million channel miles of operating systems throughout the world.

RCA Microwave Specialists will be glad to answer any questions and help plan your installation. Nation-wide services of the RCA Service Company are provided to keep entire system operating at its peak. Mail coupon for further particulars.

RADIO CORPORATION of AMERICA
COMMUNICATIONS PRODUCTS
Camden, N. J.

Radio Corporation of America
Communications Products, Dept. M-42, Building 15-1, Camden, N. J.

Please send me the latest literature on:

- ☐ RCA Multiplex Channeling Equipment
- ☐ RCA Microwave for use in.....

Name.....Title.....

Company.....

Address.....

City.....Zone.....State.....

☐ Have representative contact me.

DEMONSTRATION of slack in conductors is shown when Anaconda preassembled reverse-lay aerial cable is untwisted. Opened cables enable linemen to make connections easily—without cutting conductors or messenger.

Built-in slack helps linemen make quick taps —with Anaconda reverse-lay aerial cable

When transformers, cutouts or laterals make numerous connections necessary — Anaconda reverse-lay aerial cable permits easy separation of conductors whenever the need arises.

Lay of the conductors is reversed approximately every five feet — within easy reach of linemen. Unwound between reversal points, conductors have sufficient slack to eliminate the need for cutting conductor or messenger when making connections.

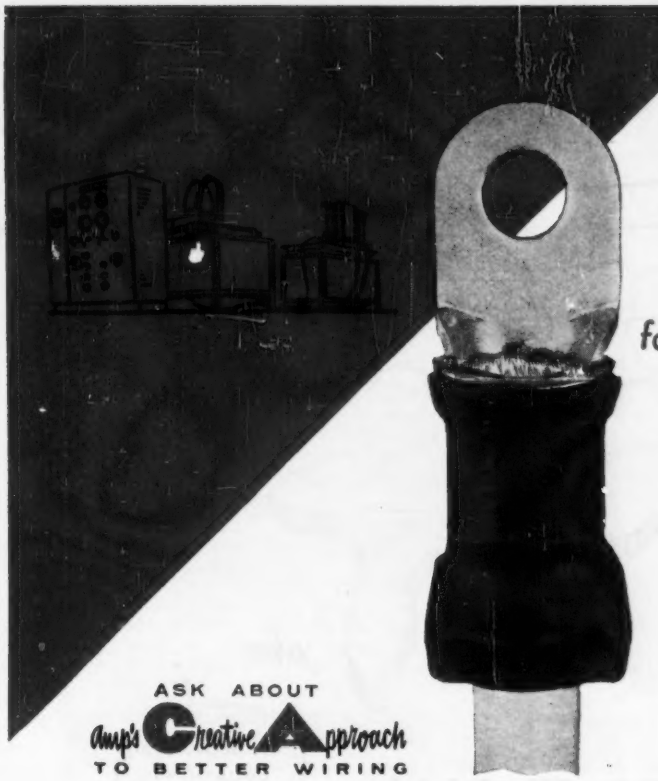
"Hot" taps can be made on 5kv nonshielded cables, eliminating power shutdowns. Opened cable allows use of wire guards and rubber blankets between the conductors for greater safety.

Ask the Man from Anaconda for full details. Call or write to: Anaconda Wire & Cable Company, 25 Broadway, N. Y. 4, N. Y.

56288 Rev.

SEE THE MAN FROM ANACONDA®

FOR AERIAL CABLE



Ampli-Bond Trade-Mark

PRE-INSULATED TERMINALS

for heavy-duty wires!

Ampli-Bond is the first and only terminal with bonded insulation and insulation support for copper wire sizes 8 through 4/0.

ASK ABOUT
amp's Creative Approach
TO BETTER WIRING

Bonded insulation, withstanding a minimum of 6000 volts, insures dielectric value. . . . An insulated metal reinforcing ring grips the insulation and protects the wire from the weakening effects of vibration and bending. . . . The terminal body is electro-tinned for high conductivity, and the dimpled inner barrel increases the contact surface and tensile strength. . . . Assures low millivolt drop.

The A-MP Dyna-Crimp Tool, with interchangeable heads and dies, crimps Ampli-Bond terminals rapidly, easily and uniformly.

Consult your local A-MP Sales Engineer or write to Harrisburg for further information.

AMP INCORPORATED

General Office: Harrisburg, Pa.

A-MP

A-MP of Canada, Ltd., Toronto, Canada
A-MP—Holland N.V., 's-Hertogenbosch, Holland
Aircraft-Marine Products (G.B.) Ltd., London, England
Societe A-MP de France, Courbevoie, Seine, France

You can SELECT at RCA!

...New Opportunities...17 + Locations...One Best For You And Your Family

Can anyone but RCA offer you a choice of locations like this?
At Camden, Moorestown or Cherry Hill, you enjoy cultural advantages of Greater Philadelphia, live at moderate cost in pleasant suburban communities. Waltham offers at-home opportunities for New England engineers. Four ideal West Coast locations. Harrison borders on Greater New York. Lancaster, Marion and Findlay have small-town advantages. There's pleasant year-round outdoor living in Cocoa Beach, on Florida's central east coast. RCA Service Company and International Division assignments include ideal locations in the United States, and wherever RCA electronic equipments are installed and serviced throughout the world.

Individual Recognition—
RCA organizes engineering activities into groups small enough to allow broadest scope for your individual accomplishment. The average group has just 11 engineers. Yet, in all activities, you are supported by the entire facilities and engineering resources of RCA.

Salaries—
RCA engineering salaries average measurably higher than other companies' in the field. Intermediate engineers, $5000-$8500; senior engineers, $8500-$15,000; staff and supervisory salaries open.

Advancement—
Scheduled, objective appraisal of your work speeds promotion. Professional and financial progress is just as sure as your achievements make it.

Professional Status—
RCA bases world leadership in electronics on the abilities of exceptional men at every organizational level. Many have notable engineering and scientific reputations. You work in day-by-day association with men of this caliber.

Benefits—
There's a complete program at RCA. A very liberal Tuition Refund Plan. Company-paid life, sickness and accident, hospital-surgical insurance for you and your family. Modern retirement plan. Relocation expenses paid. Suggestion and patent awards.

Now, Pinpoint Your Future

...Here are the Opportunities!
...Here are the Locations!

FIELDS OF ENGINEERING ACTIVITY		MANAGERS	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
			Electrical Engineers			Mechanical Engineers			Physical Science			Ceramics Glass Technology Metallurgy		
			0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• ***SYSTEMS*** *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)*	AVIATION ELECTRONICS • CONTROLS		W	W	W C	W	W	W C	W	W	W C			
	DIGITAL DATA HANDLING DEVICES	M C		M C	M C		C	C		C	C			
	MISSILE ELECTRONICS • RADAR	M W	W	M W X	M W X	W	M W	M W	W	M W X	M W X			
	INERTIAL NAVIGATION			W	W		W	W		W	W			
	COMMUNICATIONS			C N	C N						C N			
• ***DESIGN • DEVELOPMENT*** **MISSILE WEAPONS SYSTEMS**—Planning and Design—Radar—Fire Control—Servo Mechanisms—Computers		M	M X	M X	M X	M	M	M X	M	M X	M X			
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization		W C	W C X	W C X	W C X	W C	W C X	W C X	W C X	W C X	W C X			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays		M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming—Digital Data Handling Devices			C	C X	M C X	C	C X	M C X	C	C	M C			
KINESCOPES (B & W and Color), OSCILLOSCOPES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)			L	L Y	L Y	L	L Y	L Y	L	L Y	L Y	L	L Y	L Y
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development			H	H	H		H	H		H	H		H	H
SEMICONDUCTORS—Transistors—Semiconductor Devices—Materials			V	V	V	V	V	V	V	V	V	V	V	V
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)		H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing—UHF and VHF—Power			L	L	L	L	L	L	L	L	L	L	L	
COMMUNICATIONS—Specialized Systems—Microwave—Mobile—Aviation—Audio—Propagation Studies—Acoustics—Transducers			C N	C N	C N		C	C	C N	C N	C N			
BROADCAST AND TV—Monochrome and Color Studio Equipment—Cameras—Monitors—High Power Transmitters			C	C	C	C	C	C	C	C	C			
• ***SYSTEMS APPLICATION*** *(Evaluation and Planning—Design and Development—Modification—Specification)*														
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing)—Radar—Telemetry—Timing—Communications—Optics—Computers		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
COMMUNICATIONS—Radio—HF—VHF—UHF—Microwave—Telephone—Teletype—Telegraph Terminal Equipment—Wave Propagation		F I	F S I	F S I	F S I	F S	F S	F S	F S	F S	F S			
• ***MACHINE DESIGN*** **Mechanical and Electrical—Automatic or Semi-Automatic Machines**			L	L		L	L H Y	C H Y		L	L			

Locations: C—Camden, N.J. **F**—Cocoa Beach, Fla. **H**—Harrison, N.J. **I**—Clark, N.J. (periodic foreign assignments). **L**—Lancaster, Pa. **M**—Moorestown, N.J. **N**—New York, N.Y. **S**—RCA Service Co. (Cherry Hill, N.J.; Alexandria, Va.; Tucson, Ariz.; San Diego, Sacramento, San Francisco, Calif., Foreign Assignments). **V**—Somerville, N.J. **W**—Waltham, Mass. **X**—West Los Angeles, Calif. **Y**—Marion, Ind.

Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. A-14M, Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

RADIO CORPORATION of AMERICA

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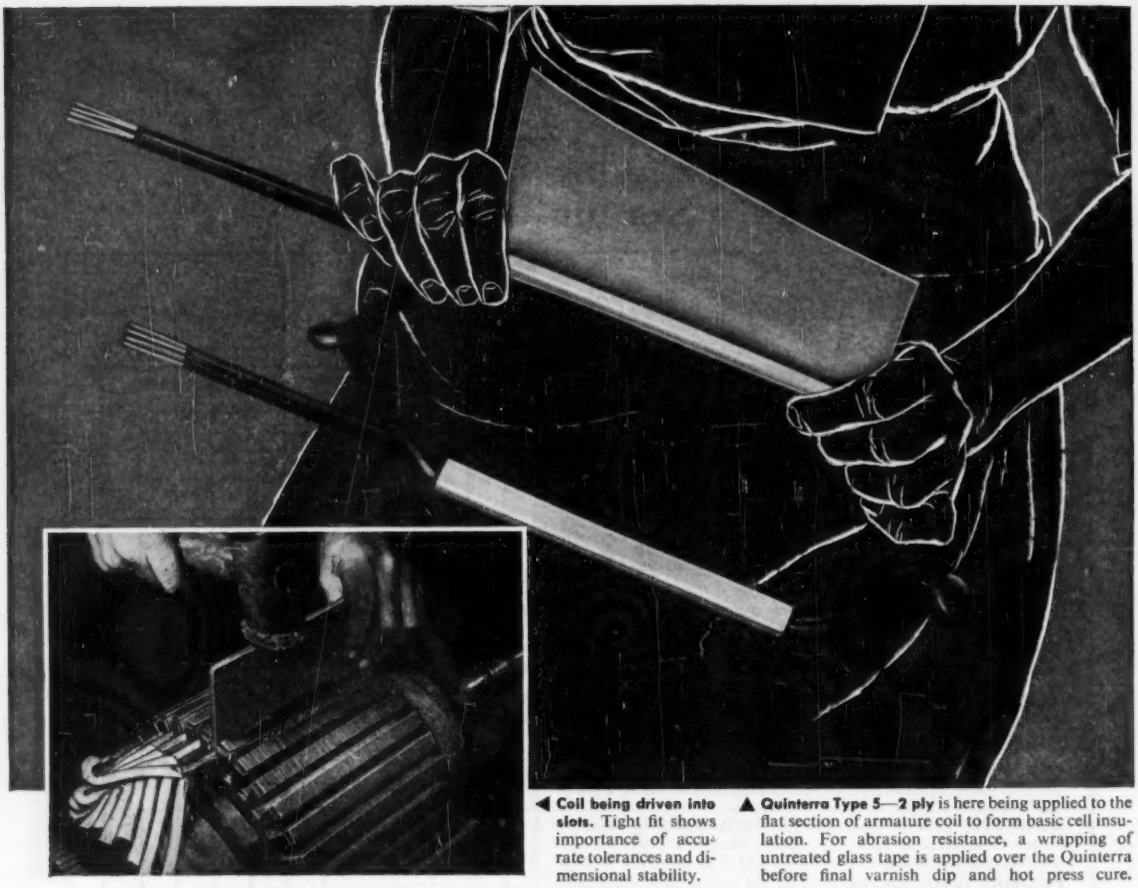


◀ **Coil being driven into slots.** Tight fit shows importance of accurate tolerances and dimensional stability.

▲ **Quinterra Type 5—2 ply** is here being applied to the flat section of armature coil to form basic cell insulation. For abrasion resistance, a wrapping of untreated glass tape is applied over the Quinterra before final varnish dip and hot press cure.

Why West Virginia Armature Co. switched to J-M QUINTERRA® *for armature coil insulation*

West Virginia Armature Co., Bluefield, W. Va., is a leading manufacturer of motor armature coils, used by the coal mining industry—a severe and difficult field. It was only after 4 years of field testing that they decided to change to Johns-Manville Quinterra Type 5—2 ply for their traditional built-up insulation materials. They made this change because they discovered that:

1 Quinterra retains higher inherent dielectric strength under prolonged high temperature operating conditions.

2 Quinterra, manufactured to closer thickness tolerances, permits more accurately dimensioned coils, assuring easy and proper fit.

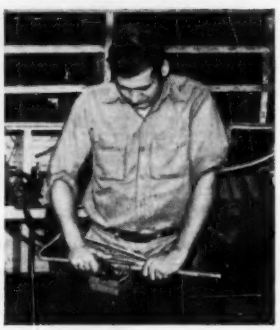
3 Quinterra is pliable, conforms readily to shape of coil and remains dimensionally stable in storage or in use.

4 Quinterra is smooth, does not crack or flake, is easy and pleasant to handle, does not harm or irritate operators' hands.

5 Quinterra is flexible, eliminates dielectric failures due to flaking or splitting.

Quinterra Type 5—2 ply is made from two sheets of highly purified asbestos treated with a polyvinyl acetate resin saturant and combined under controlled temperature and pressure. It has ample mechanical strength for easy handling. Its inherent dielectric strength exceeds 280 VPM even at temperatures over 130 C.

Find out how you can obtain the same benefits from Quinterra. Write for free 32 page illustrated brochure, EL-40A. Address Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit (Toronto), Ontario.



Dimensional accuracy is imperative. Here, finished coils are being tested in Go-or-No-Go gauge.

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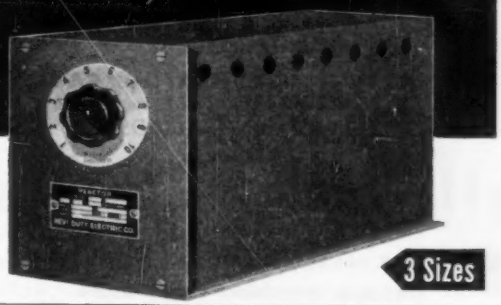

3 Sizes

TYPE NO.	KVAR at 60 Cycle	MAXIMUM AMPERES 0-10 OHMS	0-100 OHMS	0-1000 OHMS
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RD 3	3	17.5	5.5	1.8
RD 5	5	22.5	7.1	2.3

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Farsighted engineers for the new $2,300,000 Seaquarium in Miami specified 5kv Keystone-insulated feeder cables although initial voltage was only 220 volts. More than 2 miles of Keystone cable, buried directly in the sand, supply power to pumps, filter plant, underwater floodlights, P.A. systems, refrigerated fish-food vaults, and other modern conveniences that make conditions more pleasant for both man and fish. These 5kv feeders provide an excellent way of handling future increased load requirements by merely raising the distribution voltage.

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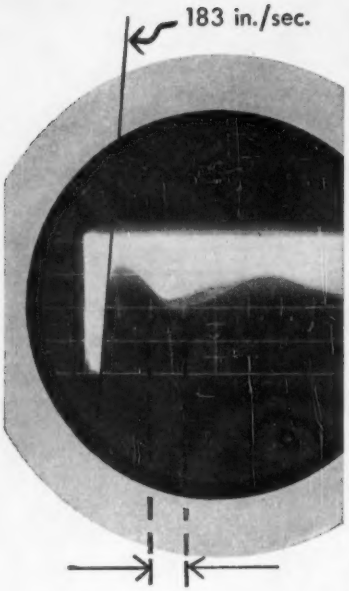

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Trade Literature

(*Continued from page 62A*)

Folder on Tapes. Pressure sensitive tapes for the aircraft industry are listed by type and application in a new handy pocket-sized folder published by Mystik Adhesive Products, 2635 N. Kildare, Chicago, Ill. The company's *Hi-Lo* temperature tapes, which retain their adhesion and high tensile strength over a temperature range of nearly 700 F are among the products featured. Composed of glass fiber cloth or Myiar(R) backing and an inorganic adhesive mass, these tapes classify as Class *A*, *B*, and *H* electrical insulation. In addition, their wide temperature range makes them ideal for nonelectrical applications such as sealing aircraft heating ducts, bundling and grouping wire and cable, and sealing containers or equipment that are to be subjected to extreme high or low ambient temperatures. Copies of the folder are obtainable free from the manufacturer.

Electronics Facts Handbook. A handy 20-page booklet entitled "Electronic Facts Handbook" has just been published. The pocket-size, attractively styled handbook is a collection of carefully selected reference data useful to people concerned with Government and industrial research and development activities. Typical among the many subjects covered are Army and Navy synchros, nomenclature for communication equipment, radar terms, frequency bands and wavelength, analog and digital computers, and conversions of wind pressures to pressures. A free copy of the valuable little booklet will be sent to those writing on company letterhead to: Public Relations Department, American Machine and Foundry Company, 261 Madison Ave., New York 16, N. Y.

"Transformers in the Making." This 16-mm sound color movie, has been released by Wagner Electric Corporation, St. Louis, Mo. The film shows progressive steps in the manufacture of power and distribution transformers including tank fabrication, coil winding, assembly, testing, and shipping. The final scenes, taken during the installation of a large power transformer, stress the importance of adequate field service. Narration is brisk and factual without being highly technical. Running time is 27½ minutes. "Transformers in the Making" may be borrowed free of charge for showing to industrial, commercial, engineering, and educational groups through Wagner sales branches located in 21 principal cities. For further information, write L. C. Dobrunz, Sales Promotion Manager, Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis 14, Mo.

NOTE:

Closing date for material to be set in the classified advertising column, as well as cancellations for running ads, must be received not later than the 25th of the 2nd month preceding; i.e., December 25th for February issue.

Thermal Evaluation of Insulating Materials

(June 1954)

At the 1954 Winter General Meeting the Subcommittee on Dielectrics and its Working Group sponsored three sessions of papers covering various phases of the problem of evaluating insulating materials. Since these papers review much of the recently developed information on this subject, it was decided to reprint them in this form. As test methods on the thermal evaluation of insulating materials become available, more and more data on thermal stability of both the newer and the older materials should develop, and eventually make possible the rational revision of AIEE Standard Number 1 on a sound basis.

The 72-page printed publication contains 16 papers and discussions, presented at the 1954 AIEE Winter General Meeting.

Publication S-61 is available at the price of $1.50 to members and nonmembers. Send orders to:

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"Gamma Rays from Neutron Inelastic Scattering,"
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"Some Techniques for Measurement of Fast Neutron Flux,"
Diven, B. C.

"Los Alamos Power Reactor Experiments,"
Froman, D. K., Hammond, R. P. and King, L. D. P.

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Hammond, R. P. and Schulte, J. W.

"Chemical Processing in Intense Radiation Fields,"
Hammond, R. P.

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Hayes, F. N., Anderson, E. C. and Langham, W. H.

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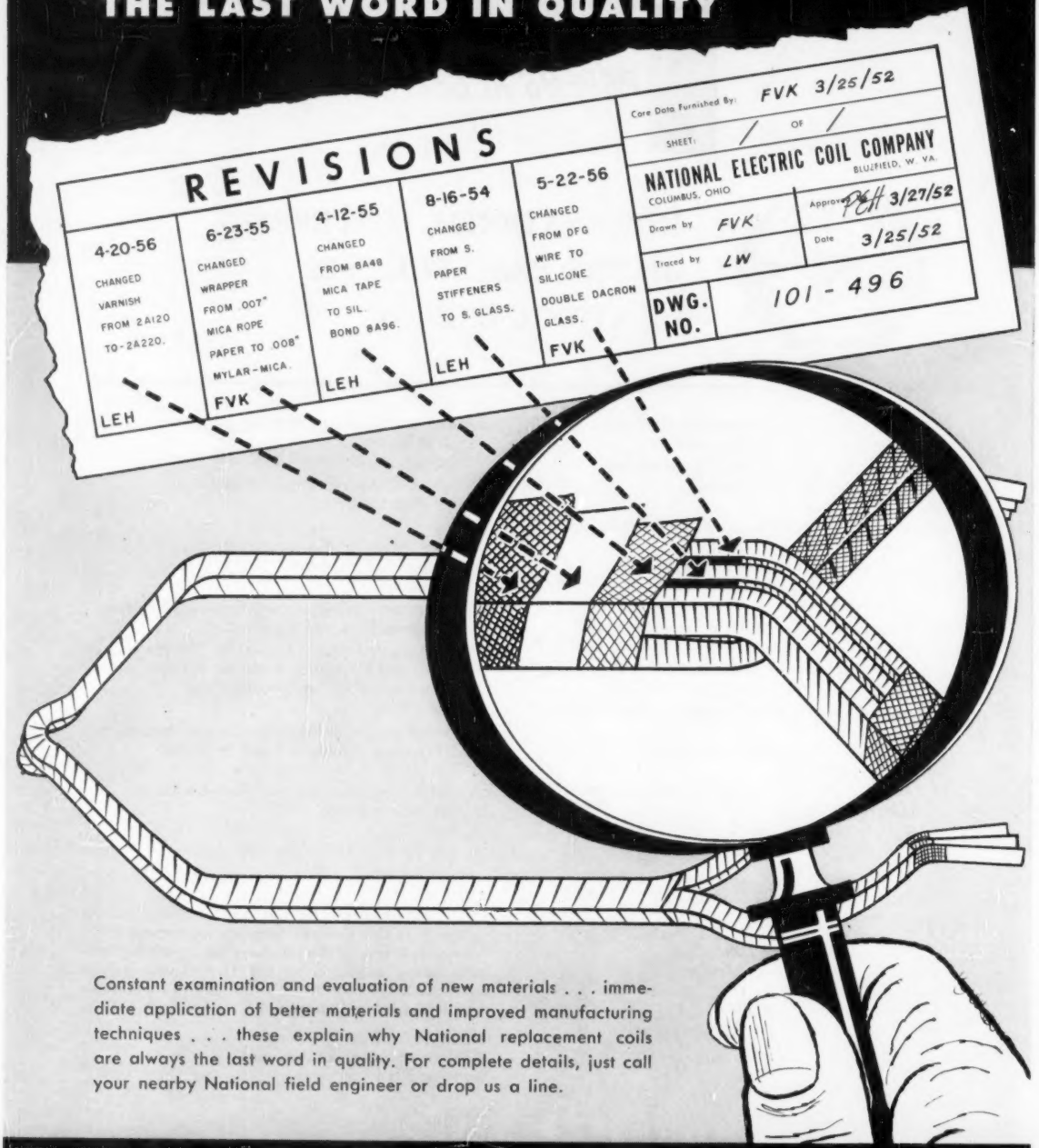

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Bibliography on Telemetering

(December 1954)

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on Telemetering
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and Measurements

This Bibliography (S-68) covers the field of mobile and stationary telemetering as it relates specifically to problems of remote measurement. The contiguous fields of carrier current transmission and supervisory control, while not excluded, are covered only in so far as there is thought to be direct bearing on the defined subject. Other bibliographies which will be directed more specifically to these related subjects are now in preparation.

In a restricted compilation such as this, it has been considered best to arrange the items in annual groups after the year 1920, when the subject began to be treated with some regularity in technical literature. Within each annual group the listing is alphabetical by author's name. No attempt has been made to strive for completeness prior to 1920 since such historical investigation would appear to have only limited, or, at best, very special interest.

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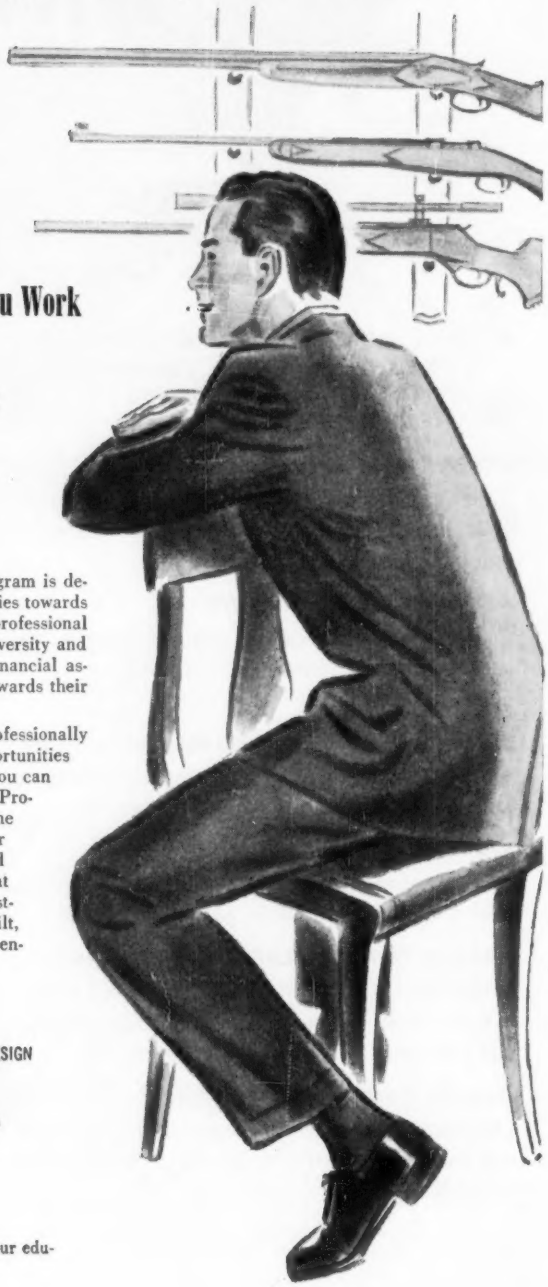

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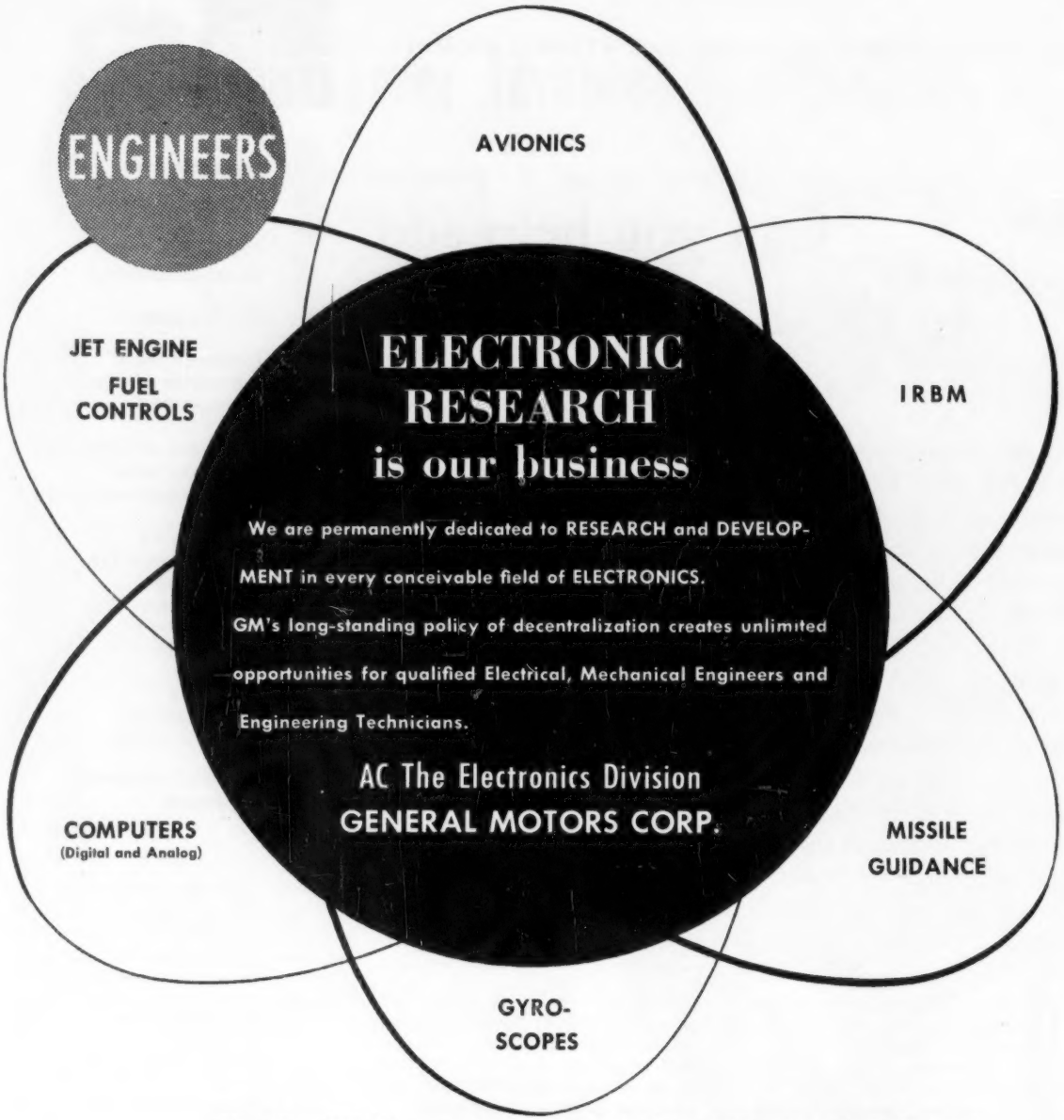

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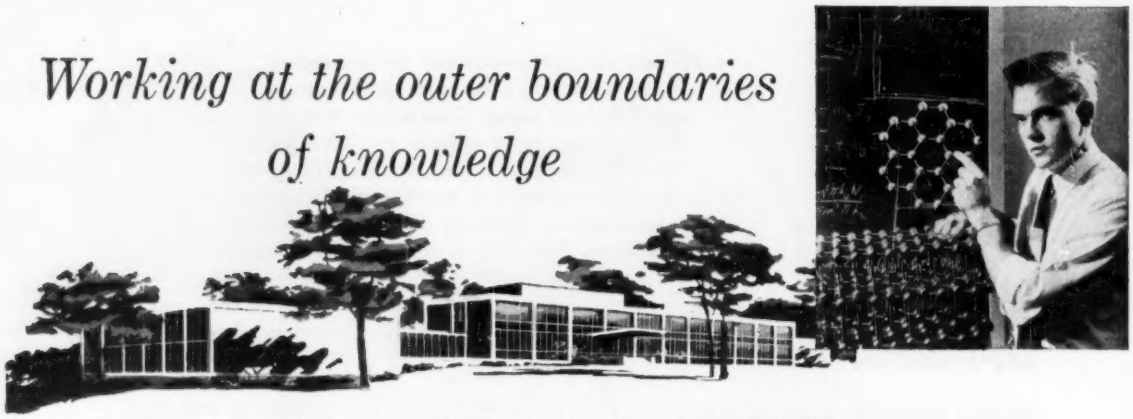
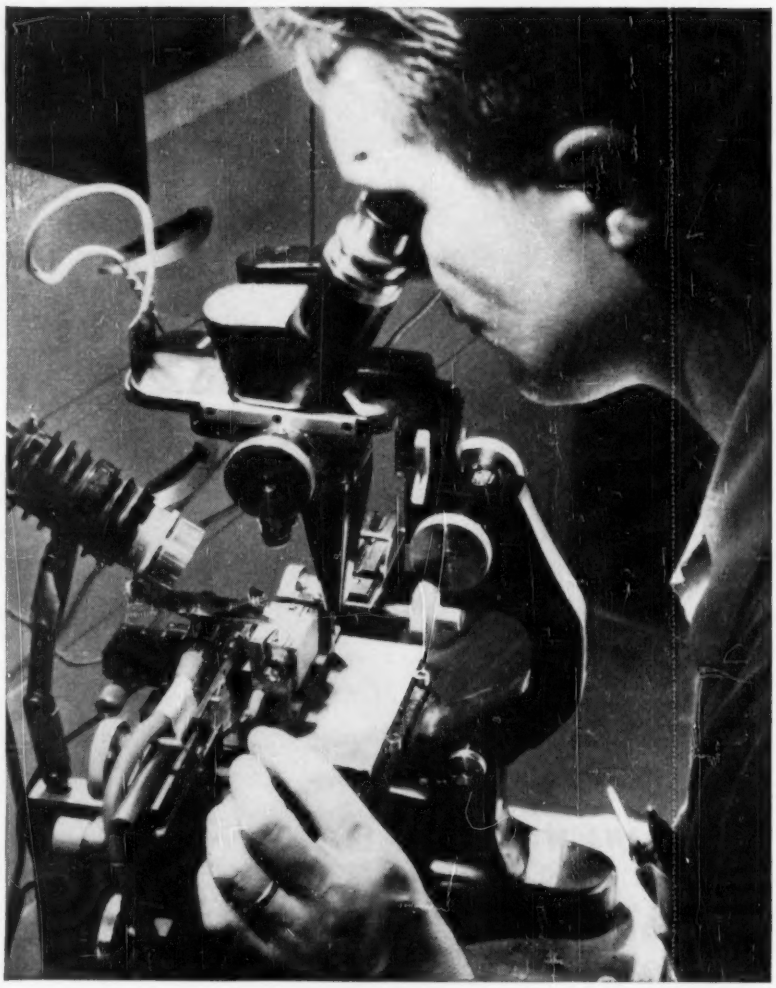
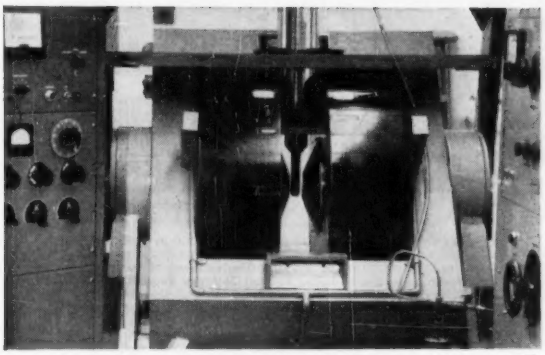


New Research Laboratories in Parma, Ohio. To expand its pioneering work in solid state and chemical physics, National Carbon Company has enlarged its staff of scientists and provided them with an ideal laboratory setup for creative work. Typical of their pioneer experimentation is current work on the "fuel cell" — a new type of battery for producing electricity directly from gases, such as hydrogen and oxygen. This is part of a far-ranging research program on all types of batteries and their carbon components.

New



Mechanized tweezers handle graphite crystal. To make it into a proper experimental guinea pig, the fragile crystal must be painstakingly cut and mounted so that electrical flow can be measured along the unique crystalline directions of graphite. Experiments with pure graphite crystals are important because all materials which we know as carbon and graphite are basically composed of the same graphite crystals being prepared here. Tremendous differences in electrical behavior and other vital properties can be traced to variation in size and arrangement of the graphite crystals in carbon products.



Graphite must pass good-conduct test. A tiny graphite crystal is chilled to within one degree of absolute zero, then held between poles of a powerful electromagnet while electrical conductivity is measured in each crystalline direction — one of many ways to learn more about carbon.

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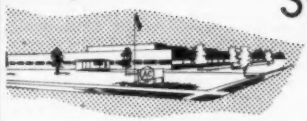

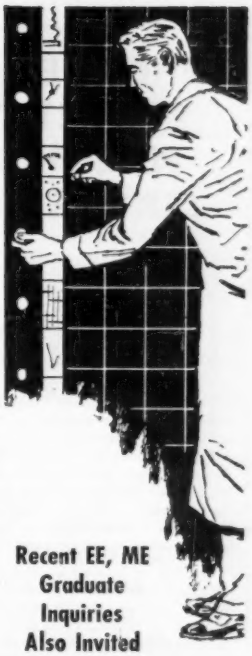

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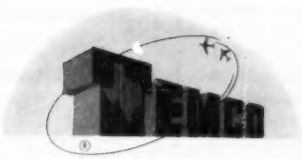

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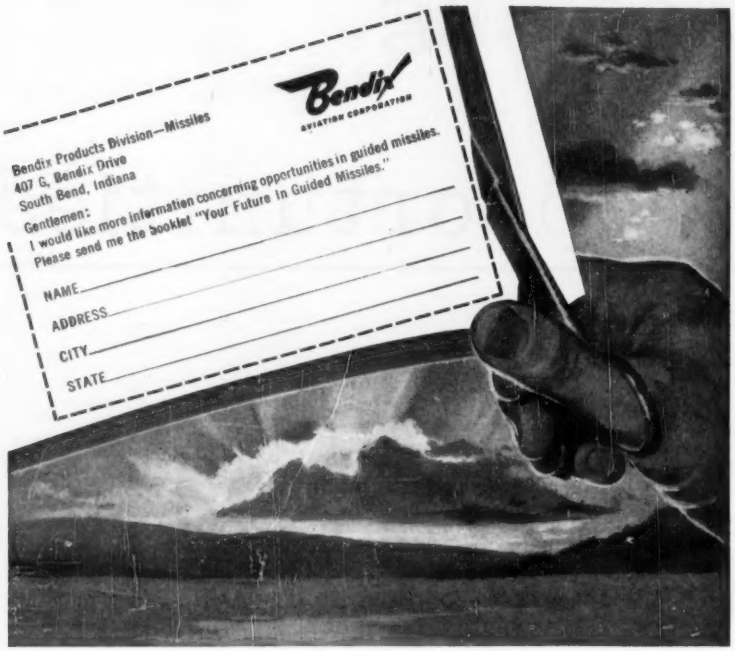

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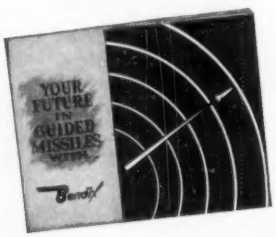

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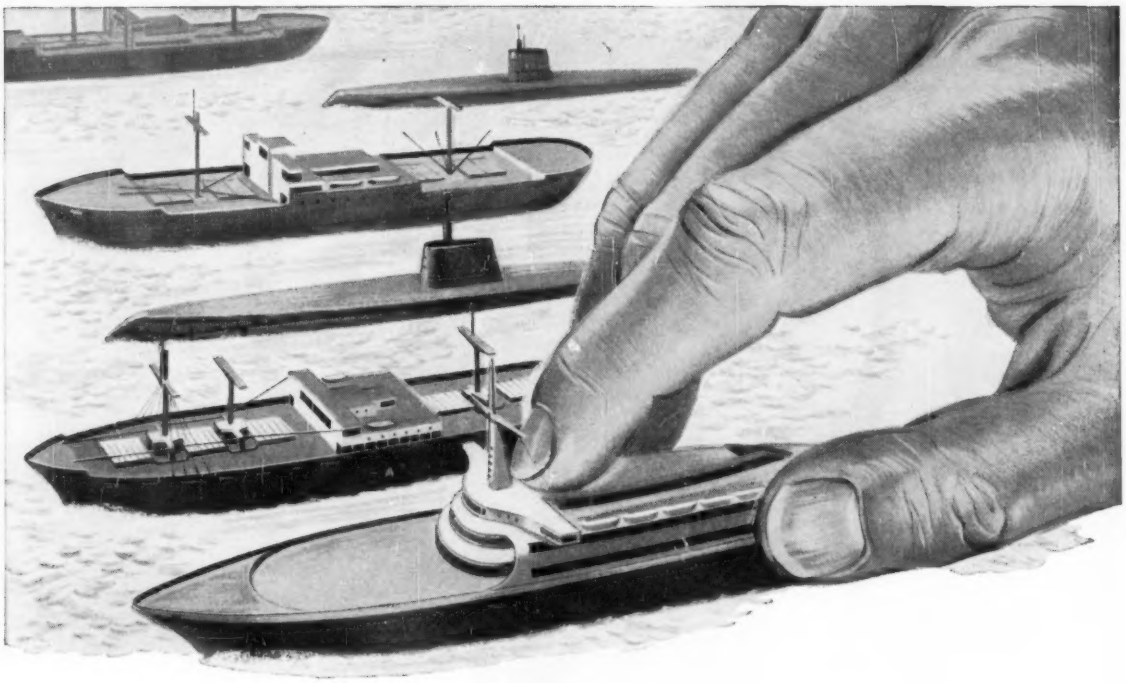

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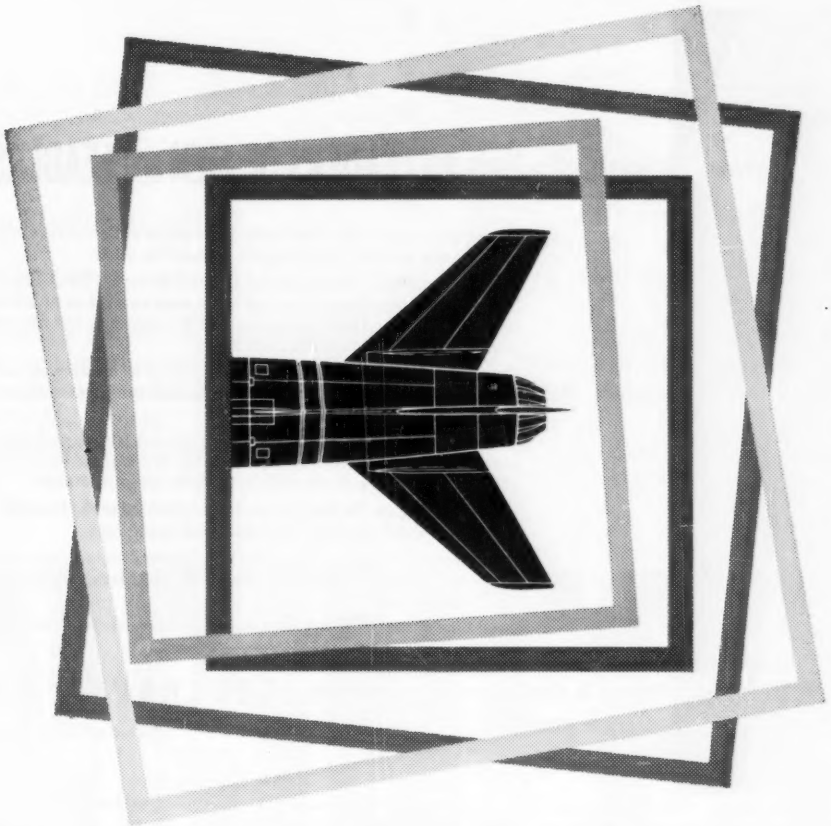

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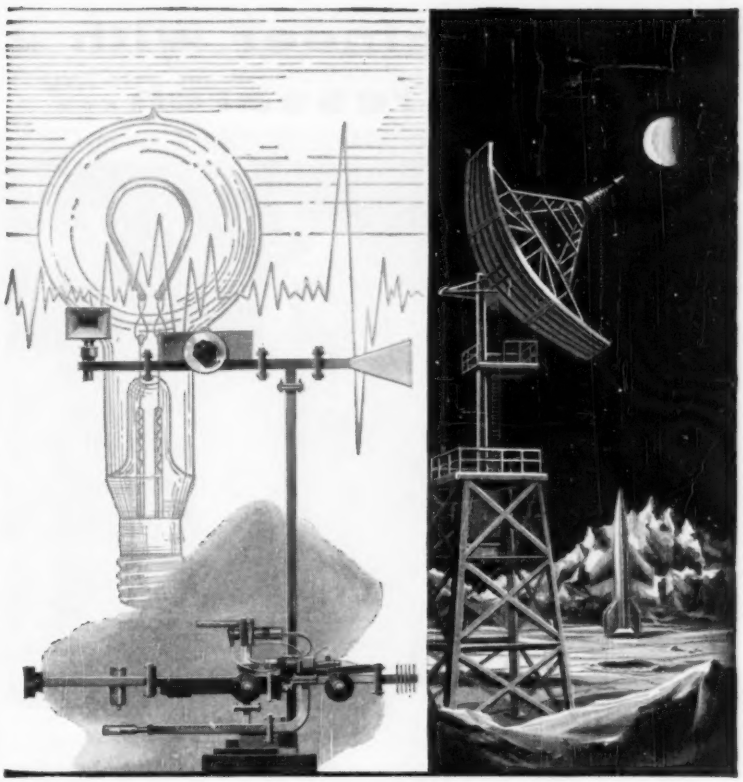

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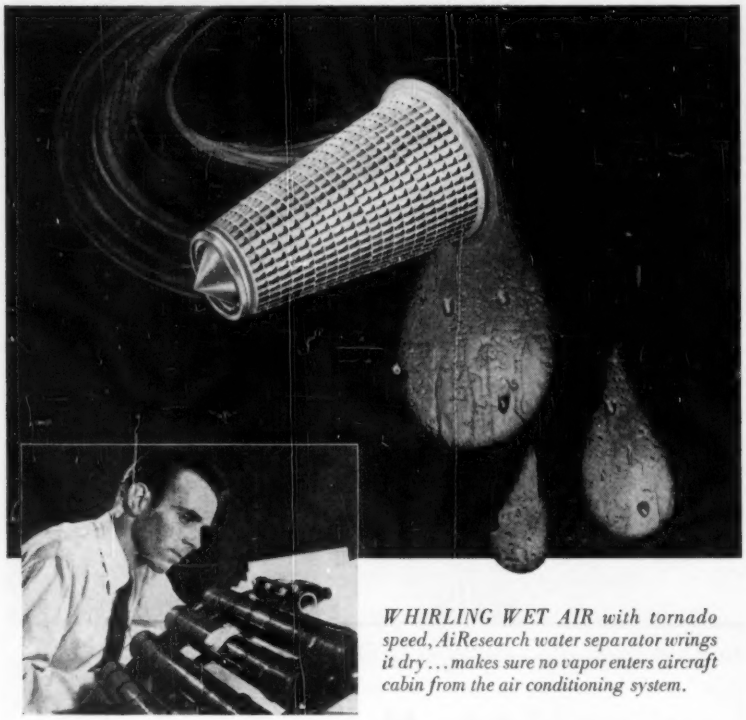

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INSTRUCTOR IN ELECTRICAL ENGINEERING—preferably one with M.Sc. degree and some industrial experience, to teach general electrical engineering subjects. Will consider one with only a B.Sc.E.E. degree if he is willing to work for M.Sc. degree. May start teaching immediately. Write Chairman, Department of Electrical Engineering, University of Nebraska, Lincoln 8, Nebraska.

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(Continued on page 102A)

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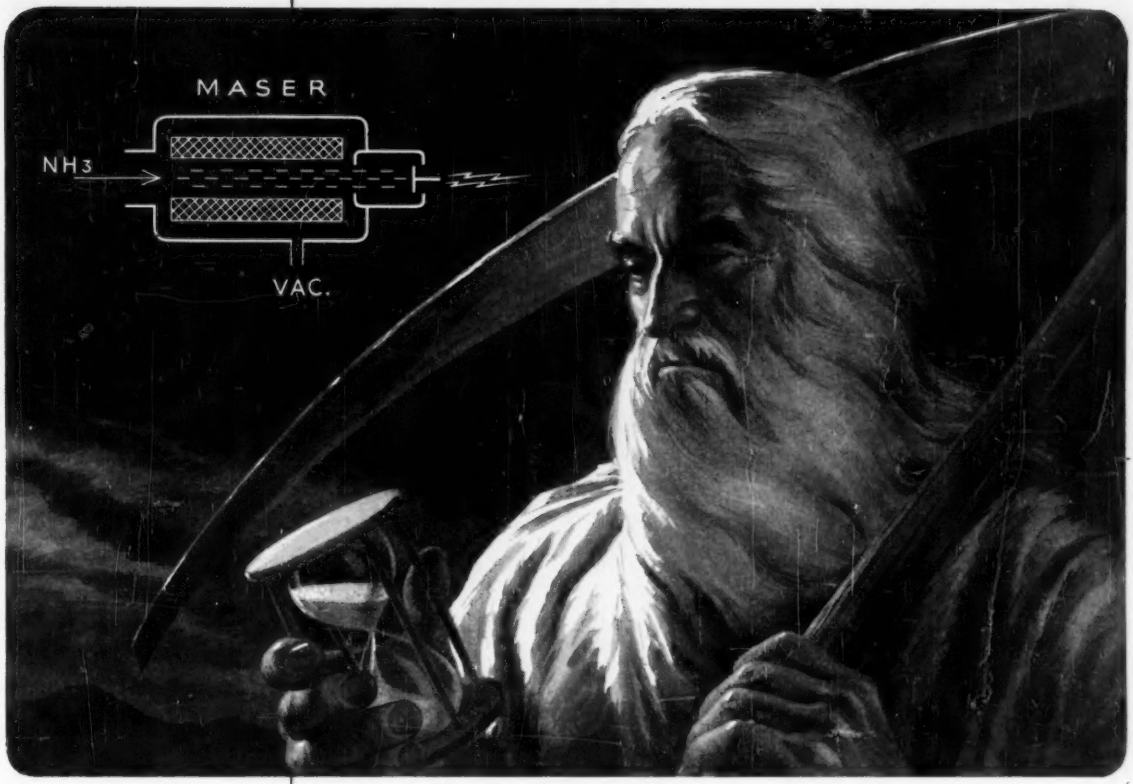

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Classified Advertising

(Continued from page 100A)

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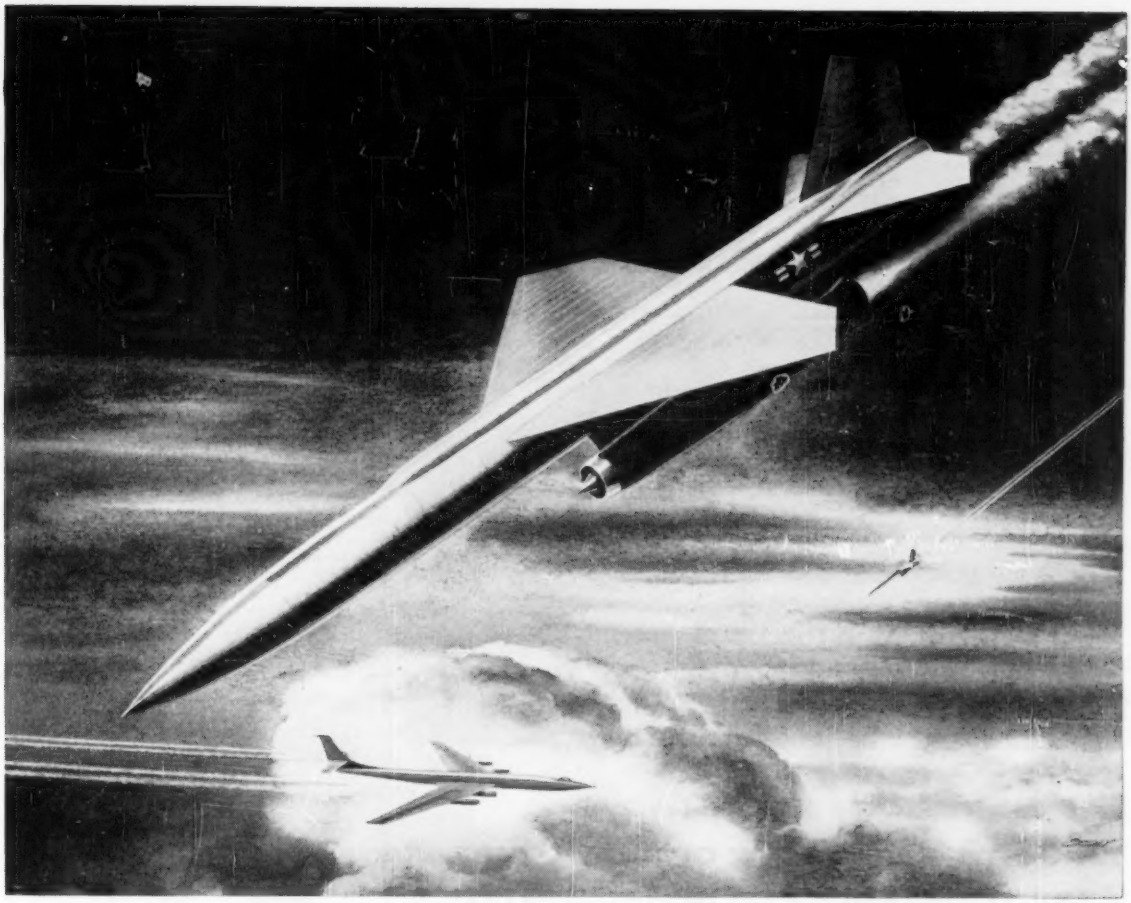
(Continued on page 104A)



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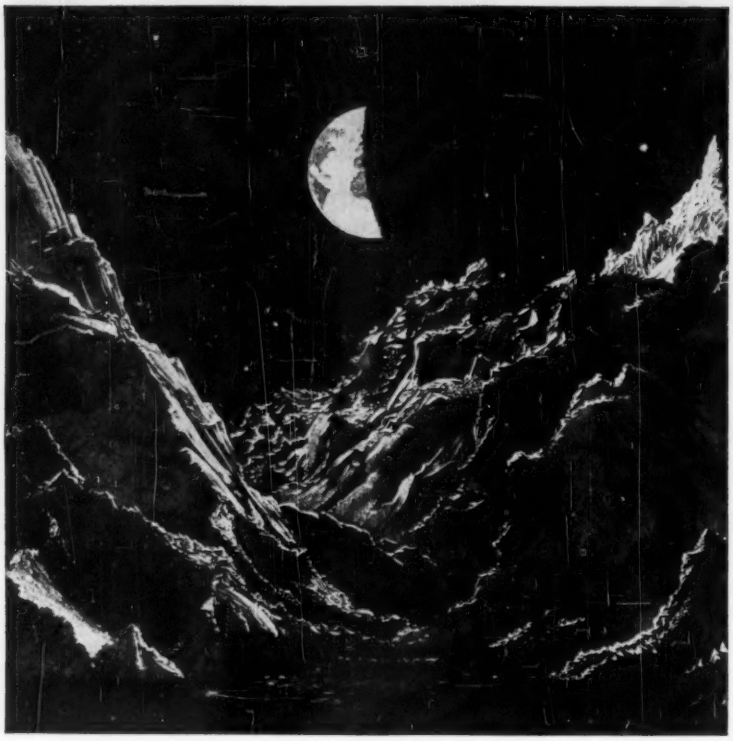

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Classified Advertising

(*Continued from page 102A*)

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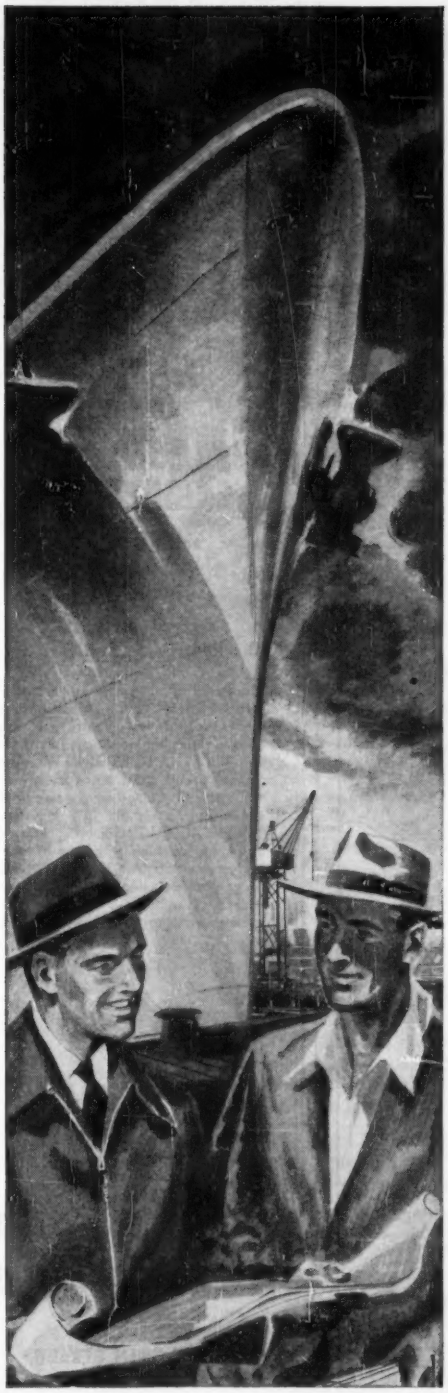

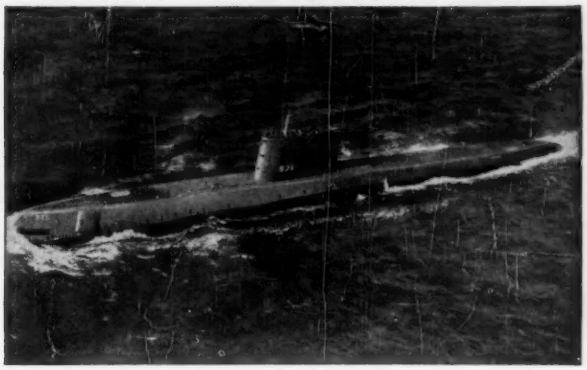

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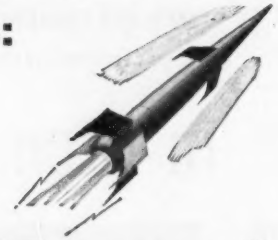

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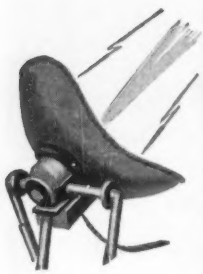

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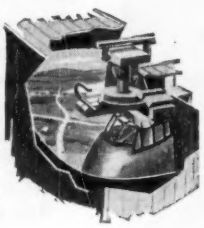

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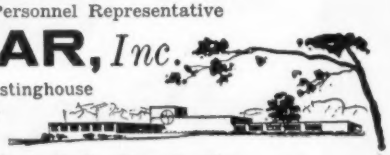

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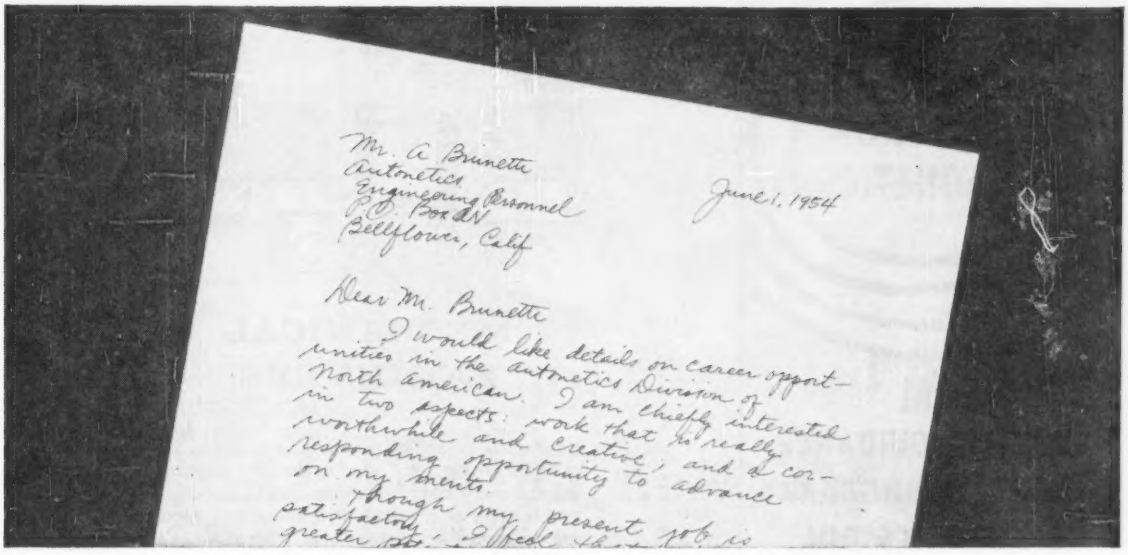
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June 1, 1954
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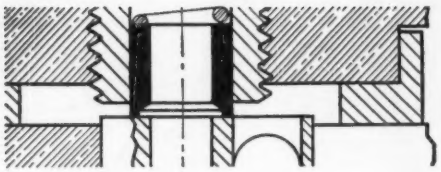

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(March 1953)

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Input-output equipment presents an ever-changing and expanding problem and encompasses a very broad field of devices. This conference stressed those devices which have been brought to the point of working equipment by the various computing groups in an attempt to acquaint a large body of engineers with the present status of the art. The 142 printed pages contain 27 pages and discussions, representing a fairly complete documentation of the input-output art as it existed at the time of publication.

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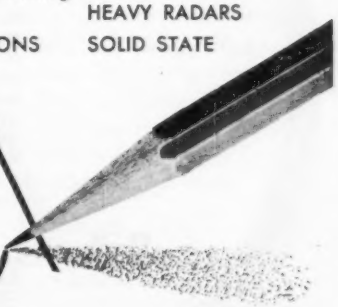

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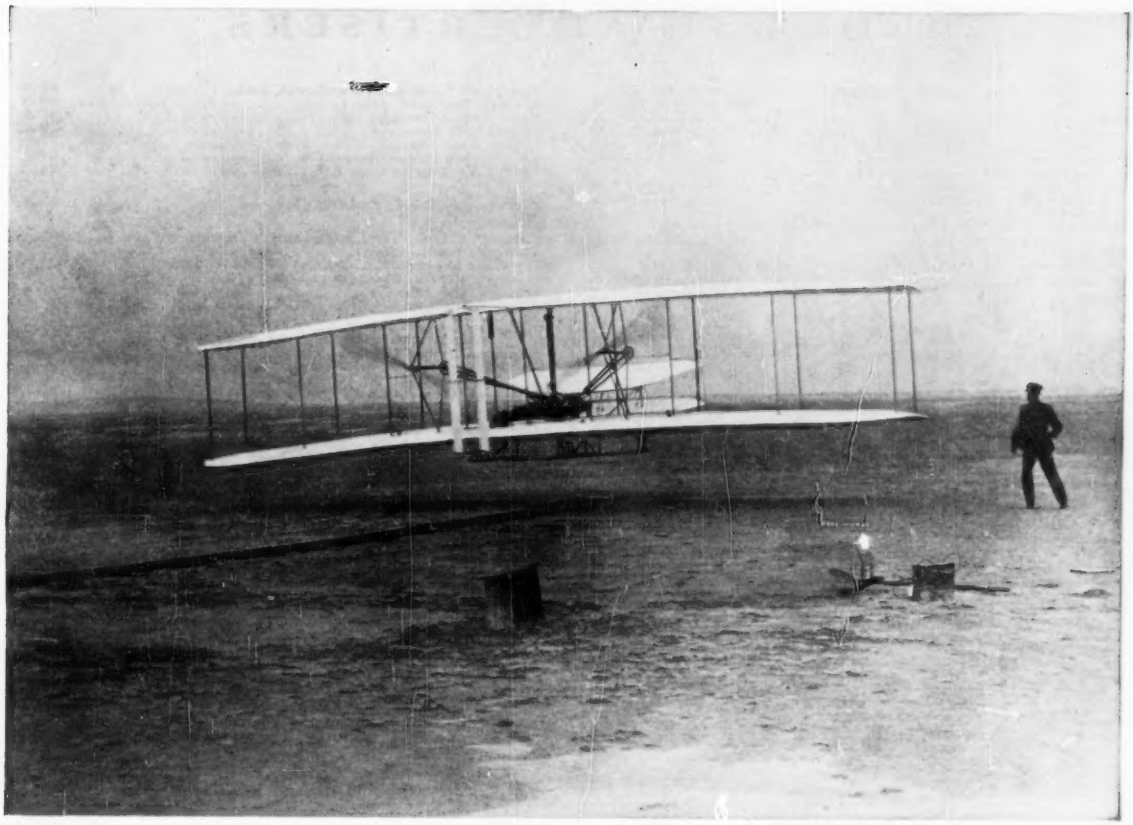

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INDEX TO ADVERTISERS

AC, The Electronics Division, General Motors Corp. ..... 84 A, 89 A, 108 A
Acme Electric Corp. ..... 32 A
AIEE Special Publications ..... 39 A, 76 A, 79 A, 104 A, 109 A
Allis-Chalmers Manufacturing Co. ..... 2nd cover
American Brass Co., The ..... 35 A
American and Foreign Power Co., Inc. ..... 110 A
AMP Incorporated ..... 69 A
Anaconda Wire and Cable Co. ..... 68 A
Andrew Corp. ..... 92 A
Armour Research Foundation of Illinois Institute of Technology ..... 92 A, 96 A
Arnold Engineering Co., The ..... 114 A
Autonetics, A Division of North American Aviation, Inc. ..... 107 A

Bakelite Co. ..... 53 A
Battelle Memorial Institute ..... 89 A
Bechtel Corp. ..... 89 A
Beckman Instruments, Inc. ..... 96 A
Bell Aircraft Corp. ..... 99 A
Bell Telephone Laboratories ..... 46 A
Bendix Aviation Corp. ..... 36A, 73 A, 92 A
Biddle Co., James G. ..... 79 A
Boeing Airplane Co. ..... 103 A
Bulova Watch Co., Inc. ..... 110 A
Burndy Engineering Co. ..... 9 A
Bussmann Manufacturing Co. ..... 4 A–5 A

Caledonia Electronics & Transformer Corp. ..... 76 A
Cannon Electric Co. ..... 42 A–43 A
Chase-Shawmut Co., The ..... 18 A
Clark Controller Co., The ..... 29 A
Classified Advertising ..... 100 A, 102 A, 104 A
Continental-Diamond Fibre Division of the Budd Co., Inc. ..... 58 A
Continental Electric Equipment Co. ..... 61 A
Curtiss-Wright Corp. ..... 40 A

Dale Products, Inc. ..... 24 A
Dow Corning Corp. ..... 41 A

Eastman Chemical Products, Inc. ..... 65 A
Ebasco Services, Inc. ..... 96 A
Eitel-McCullough, Inc. ..... 38 A
Electrons, Inc. ..... 30 A
Enjay Co., Inc. ..... 37 A
Enterprise Galvanizing Co. ..... 24 A
Esterline-Angus Co., Inc., The ..... 24 A

Firestone Tire & Rubber Co. ..... 13 A

Garrett Corp., The, AiResearch Division ..... 100 A
General Cable Corp. ..... 21 A
General Electric Co. ..... 10 A–11 A, 28 A, 52 A, 66 A, 88 A, 96 A
General Radio Co. ..... 3rd cover
Gibson Electric Co. ..... 22 A
Goodrich Chemical Co., B. F. ..... 60 A

Hathaway Instrument Co. ..... 26 A
Hevi Duty Electric Co. ..... 28 A, 73 A
Hoffman Laboratories, Inc. ..... 110 A
Hughes Aircraft Co. ..... 7 A, 23 A
Hughes Research and Development Laboratories. ..... 22 A

Ilsco Corp. ..... 28 A
Industrial Notes ..... 14 A, 16 A, 20 A, 26 A, 30 A, 38 A, 40 A, 44 A, 62 A, 76 A
International Business Machines Corp. ..... 80 A
International Rectifier Corp. ..... 57 A
I-T-E Circuit Breaker Co., Switchgear Division ..... 25 A

Jack and Heintz, Inc. ..... 32 A
Jennings Radio Manufacturing Corp. ..... 45 A
Jet Propulsion Laboratory, Caltech ..... 101 A
Johns-Manville ..... 55 A, 72 A

Kay Lab ..... 18 A
Kepco Laboratories, Inc. ..... 15 A
Kerite Co., The ..... 51 A
Knopp, Inc. ..... 34 A
Koppers Co. ..... 96 A

Lapp Insulator Co., Inc. ..... 6 A, 110 A
Lincoln Laboratory, M.I.T. ..... 109 A
Los Alamos Scientific Laboratory ..... 77 A

Magnetics, Inc. ..... 54 A
Marcus Transformer Co., Inc. ..... 20 A
Martin Co., The Glenn L. ..... 104 A
Melpar, Inc. ..... 106 A
Morganite, Inc. ..... 44 A
Motorola, Inc. ..... 102 A

National Carbon Co. ..... 86 A–87 A
National Cash Register Co., The ..... 97 A
National Electric Coil Co. ..... 78 A
North American Aviation, Inc. ..... 95 A, 107 A, 111 A
Northrop Aircraft, Inc. ..... 108 A

Ohio Brass Co. ..... 47 A–50 A
Ohio Carbon Co., The ..... 14 A
Ohmite Manufacturing Co. ..... 59 A
Okonite Co., The ..... 2 A, 75 A

Pacific Division, Bendix Aviation Corp. 36A
Pennsylvania State University, The—Ordnance Research Laboratory ..... 88 A
Personnel Service, Inc. ..... 73 A, 90 A
Professional Engineering Directory ..... 98 A
Pyle-National Co., The ..... 34 A

Radio Corporation of America ..... 4th cover, 67 A, 70 A–71 A, 93 A
Radio Engineering Products ..... 16 A
Raytheon Manufacturing Co. ..... 34 A
Research-Cottrell, Inc. ..... 20 A
Rockbestos Products Corp. ..... 8 A
Roebling's Sons Corp., John A. ..... 17 A
Roll-A-Reel ..... 28 A
Rome Cable Corp. ..... 56 A

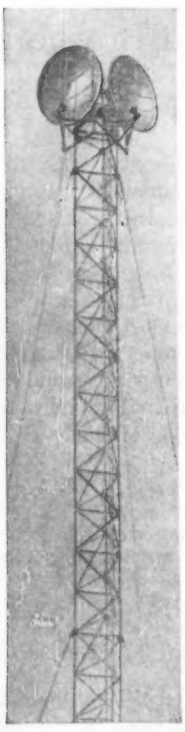
Sandia Corp. ..... 81 A
Simplex Wire and Cable Co. ..... 27 A
Southern States Equipment Corp. ..... 64 A
Spencer Thermostat Division, Metals and Controls Corp. ..... 74 A
Sprague Electric Co. ..... 12 A
Square D Co. ..... 63 A
Standard Transformer Co., The ..... 62 A
Stromberg-Carlson Co. ..... 112 A

Temco Aircraft Corp. ..... 91 A
Trans World Airlines ..... 85 A

United States Rubber Co. ..... 31 A
Union Carbide Nuclear Co. ..... 89 A
University of California, Radiation Laboratory ..... 83 A
Uptegraff Manufacturing Co., R. E. ..... 19 A

Victor Insulators Division, I-T-E Circuit Breaker Co. ..... 33 A

Western Insulated Wire Co. ..... 24 A
Westinghouse Electric Corp. ..... 36 A, 82 A, 94 A, 105 A, 113 A



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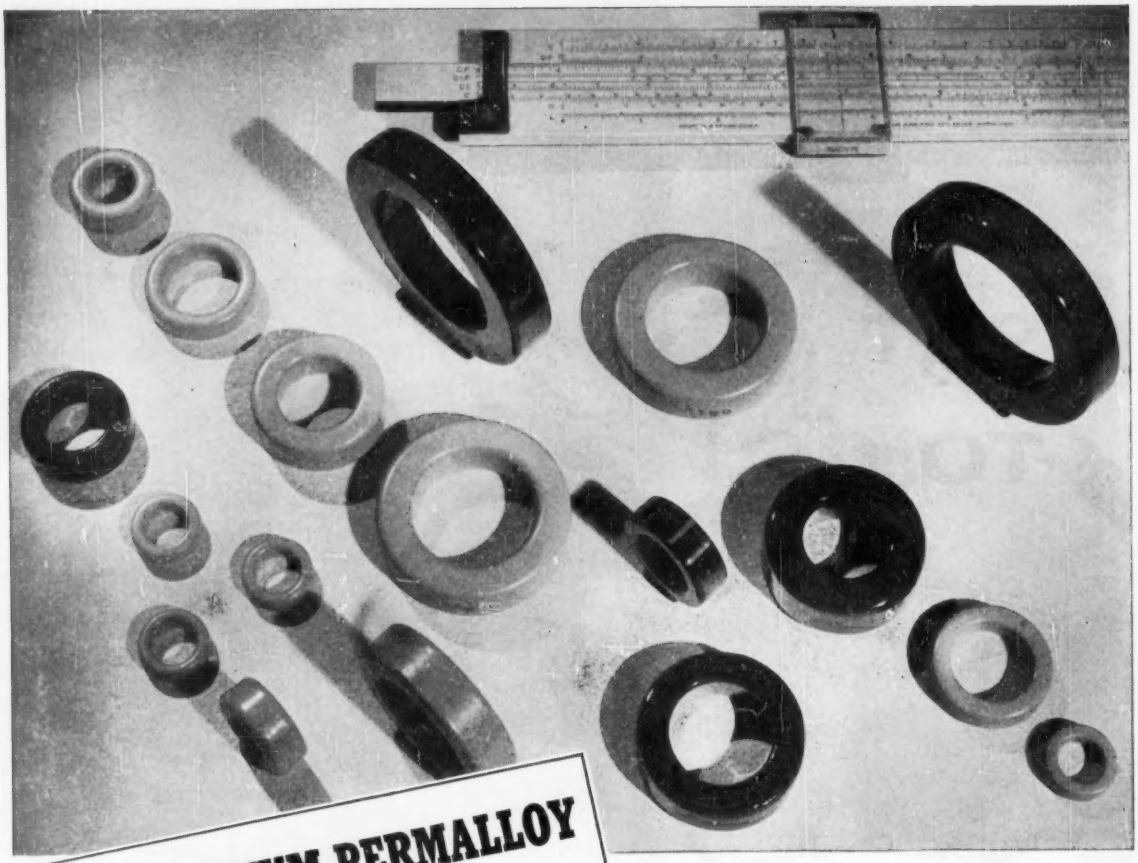

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For high Q in a small volume, characterized by low eddy current and hysteresis losses, ARNOLD Moly Permalloy Powder Toroidal Cores are commercially available to meet high standards of physical and electrical requirements. They provide constant permeability over a wide range of flux density. The 125 Mu cores are recommended for use up to 15 kc, 60 Mu at 10 to 50 kc, 26 Mu at 30 to 75 kc, and 14 Mu at 50 to 200 kc. Many of these cores may be furnished stabilized to provide constant permeability (±0.1%) over a specific temperature range.

For Bulletin—ADDRESS DEPT. EL-612

WSW 6328

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

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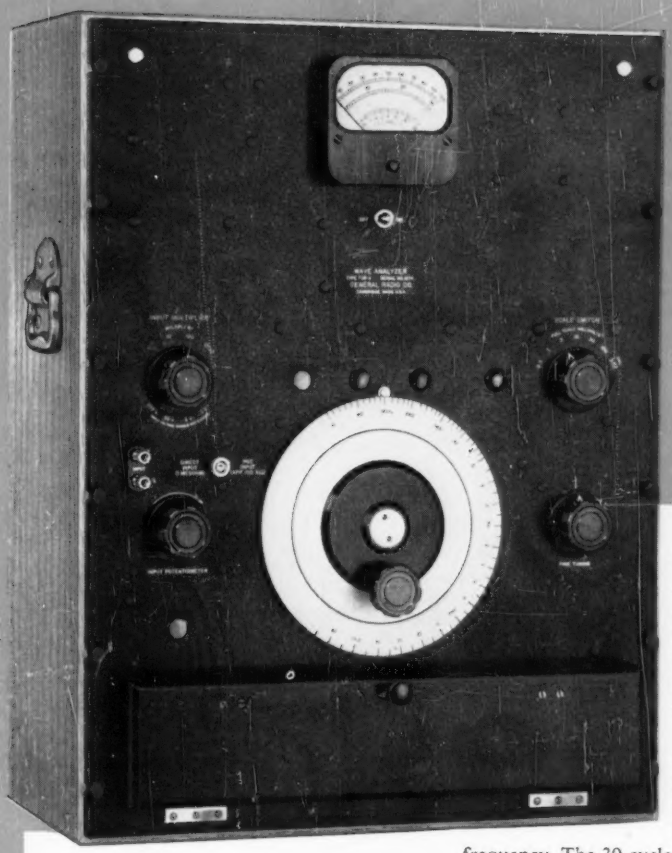


Type 736-A Wave Analyzer, $1150

Wave Analyzer

This Analyzer provides the most accurate and direct method of separating the components of a complex electrical waveform so as to measure their amplitudes and frequencies. In its essentials it is a heterodyne-type vacuum-tube voltmeter which utilizes a unique network of three quartz-crystal filters for selectivity and exceptional sharpness of tuning.

Ease of use is an important feature. The instrument is direct reading over a very wide voltage range of 10 microvolts to 300 volts inclusive, and when making comparative measurements, harmonics can be identified as low as 80 db below the fundamental frequency. The 30-cycle off-resonance selectivity is down at least 60 db . . . a factor of 10-1 better than that of any comparable instrument.

The Wave Analyzer is ideally suited for measurements on all kinds of audio-frequency equipment, oscillators, amplifiers, telephone and public address systems, broadcast receivers and transmitters and other vacuum-tube circuits. Noise and hum measurements and analyses are also possible. As a sharply tuned voltmeter, the Wave Analyzer is invaluable in the measurement of the transmission characteristics of electrical wave filters. In addition, it has wide application outside the electronics laboratory, as in the determination of harmonics of electrical power systems and electrical machinery.

Frequency Range: 20 cycles to 16 kilocycles

Frequency Calibration Accuracy: ±(2% + 1 cycle)

Selectivity: substantially flat 4-cycle bandpass over frequency range — see typical quartz-crystal filter characteristic at right

Input Voltage Range: 0.0003 to 300 volts full scale

Voltage Accuracy: within ±5% on all ranges

Modulation Products Suppressed: by at least 70 db

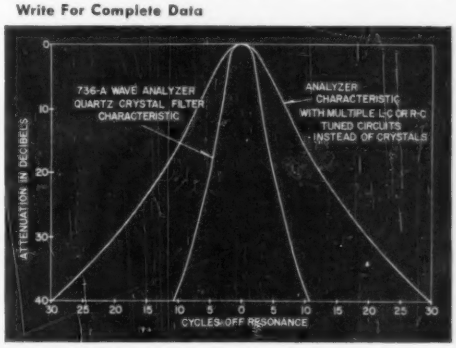
Hum Suppressed: 75 db

Input Impedance: 1 megohm for direct voltage measurements; 100,000 ohm with input potentiometer

Built-in Calibration System: for both voltage and frequency

Write For Complete Data

Quartz-Crystal Filters for Flat-Top Response . . . and Steep Skirt Drop-Off


736-A WAVE ANALYZER QUARTZ CRYSTAL FILTER CHARACTERISTIC
ANALYZER CHARACTERISTIC WITH MULTIPLE L-C OR R-C TUNED CIRCUITS INSTEAD OF CRYSTALS
ATTENUATION IN DECIBELS
0
10
20
30
40
30 25 20 15 10 5 0 5 10 15 20 25 30
CYCLES OFF RESONANCE

GENERAL RADIO Company

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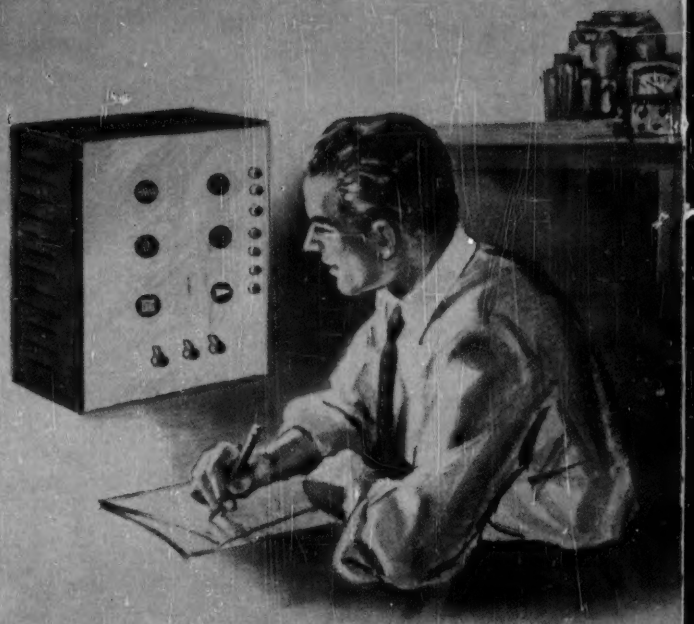
RCA-1EP1...-1EP2...-1EP11

1 1/16"-screen, 2-ounce

OSCILLOGRAPH TUBES

...new additions to the comprehensive line of RCA oscillograph tubes for commercial and military electronics.



The versatile RCA-1E-series affords engineers new opportunities in the design and development of compact airborne electronic equipment, portable test apparatus, and devices for continuous circuit-monitoring. These are but *three of the many* types constantly being added to RCA's broad line of oscillograph tubes. In addition to the new 1EP1, 1EP2, and 1EP11, the following 3" and 5" types have been recently announced to electronic-equipment designers: 3WP1, 3WP2, 3WP11, 5AHP7, 5AHP7-A, 5FP14-A, 5FP15-A.

For sales information on these and the *many other* RCA OSCILLOGRAPH TUBES, contact the RCA DISTRICT OFFICE nearest you:

EAST: HUmboldt 5-3900
744 Broad Street
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MIDWEST: WHitehall 4-2900
Suite 1181, Merchandise Mart Plaza
Chicago 54, Ill.

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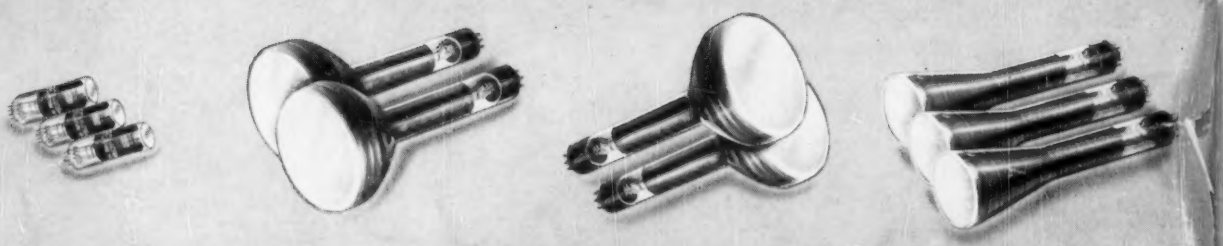
Los Angeles 22, Calif.

For technical data on Oscillograph Tubes, write RCA, Commercial Engineering, Section L-16-R Harrison, N. J.

RADIO CORPORATION of AMERICA
Tube Division
Harrison, N. J.



RCA-1EP1, -1EP2, and -1EP11... Medium-, long-, and short-persistence types, respectively, utilizing electrostatic focus and electrostatic deflection. Each has flat face...maximum outside diameter of only 1-1/4" with minimum useful screen diameter of 1-1/16"...maximum overall length of 4-1/16"...weighs only 2 ounces!

RCA-5FP14-A and -5FP15-A... 5FP14-A intended particularly for radar-indicator service and 5FP15-A for photographic recording of electrical phenomena including radar signals—both types feature high-resolution capability. Employing magnetic focus and magnetic deflection—each has deflection angle of 53° and minimum useful screen diameter of 4-1/4".

RCA-5AHP7 and -5AHP7-A... For radar-indicator service and general oscillographic applications. Feature low-voltage electrostatic-focus guns to assure good uniformity of focus over entire screen and to permit automatic maintenance of focus with wide range of line-voltage variation and image-brightness adjustment. 5AHP7-A has aluminized screen for increased brightness and improved image contrast.

RCA-3WP1, -3WP2, and -3WP11... Medium-, long-, and short-persistence types, respectively, for oscillographic applications requiring extremely high deflection sensitivity. Each has flat face and minimum useful screen diameter of 2-3/4". Maximum overall length is 11-5/8".